12.11.02

HIGH FREQUENCY SURFACE WAVE RADAR TEST IN PRINCE WILLIAM SOUND

Project Number:	02640
Restoration Category:	Ecosystem Synthesis/GEM transition
Proposer:	Alaska Marine Technology Corporation
Lead Trustee Agency:	
Alaska SeaLife Center:	No
Duration:	One year, FY 02
Cost FY 02:	Two complete tests $121,000
Cost FY 03:	Additional tests $120,000
Geographic Area:	Prince William Sound, Alaska
Injured Resource/Service:	

ABSTRACT

Alaska Marine Technology Corp. (AMT). proposes to analyze surface currents in Prince William Sound with a portable short-range, high-frequency surface wave radar system (HF-SWR). AMT will provide, deploy and operate the system.

Use of this advanced technology will increase knowledge and understanding of the overall distribution of currents in the sound, and will add significantly to existing information about the sound's circulation obtained from models such as those developed by Wang, Deleersnijder, Mooers and others.

Once deployed and operating, this system will provide real-time and archived data about ocean surface currents in the sound. Observations will include current speed, current direction, diversion flow and upwelling dynamics. The complete HF-SWR system will consist of two radars that are capable of measuring current vectors in real time out to a distance of fifty miles.

INTRODUCTION

In looking at an ecosystem where simple feeding chains are apparent, closer analysis will generally reveal that they are part of a more complex food web. Whether simple or complex, these food webs depend on the minute drifting plant life known as phytoplankton. In turn, the abundance of phytoplankton is determined by circulation, current systems and upwelling of nutrient-rich waters.

The fertility of a marine region affects the type of plant and animal community it may support. Phytoplankton is fed upon by herring, which themselves are preyed upon by seabirds. Herring are also an important food source for marine mammals, including harbor seals, sea lions and dolphins. Direct feeding links also exist between many of these predatory animals.

An understanding of the rich nutrients that circulate upward from deeper waters plays an important part in understanding biological diversity, population dynamics, and other aspects of the Prince William Sound marine ecosystem. Identifying areas in the sound subject to nutrient-rich upwelling will enhance our understanding of the sound's food chain, which in turn is essential to effective restoration efforts.

AMT proposes to set up the radar and monitor the currents at two locations in Prince William Sound, producing data that can serve as a basis for modeling the movement of the sound's surface currents in those areas. Each deployment will be for a period of three weeks with radar operating 24 hours a day. The investigators will prepare a report presenting and analyzing the data obtained during these deployments.

NEED FOR THE PROJECT

A. Statement of Problem

In our view, incomplete information about the nature and behavior of surface currents in Prince William Sound has hindered a complete understanding of nutrient circulation and its relation to biological populations.

Fruitful research has been conducted over the past 11 years in the sound focusing on deep water circulation and its relationship to the abundance and health of fisheries and mammals. Surface currents, however, is an area of study in which far less data has been collected.

B. Rationale/Link to Restoration

The surface currents of PWS without a doubt comprise one of the most complicated ocean systems in Alaska. Even experienced ship handlers in the sound frequently have questions about the movement of waters in this complex archipelago.

Understanding the sound's surface currents will help explain marine circulation in the sound and show areas of up welling. That is so important for the provision of nutrients to the food chain, from plankton and herring up to the fish, birds and mammals that prey upon them.

Once additional surface current data is generated, other research groups will be able to use this data to complete their projects. Such data will be helpful in the areas of fisheries research and management, other ecosystem research, predator-prey relationships and current erosion in coastal and inland waterways.

(In addition, such data could be important to efforts by the State of Alaska and maritime entities to improve shipping safety in Prince William Sound.)

C. Location

Prince William Sound will be divided into two areas: the central sound and Hinchinbrook Entrance. The project will provide a general overview of currents in the central sound and provide an understanding of current dynamics entering the sound at Hinchinbrook Entrance.

The investigators will complete site selection in March corresponding with a survey of the area by plane or boat. Attributes of an acceptable site will need to include an open area suitable for the erection of an antenna system, easy access to a loading area, and some areas sheltered from the weather.

For the first site, intended to observe currents in the central sound, numerous locations are available. Fewer satisfactory sites are available for the Hinchinbrook Entrance deployment, but the investigators have several candidate locations in mind and are confident a satisfactory location can be found.

The observations will be conducted during the summer months to reduce weather-related problems for the researchers.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

While the investigators do not expect their activities to directly affect any Prince William Sound community, advance notice will be given to the sound's residents via community service announcements on local radio stations, combined with press releases to the weekly newspapers serving the Sound. This will be done as a courtesy to those local mariners and pilots observe the radar deployment and operation and are interested to know what it is.

Upon completion of the project residents of the communities of Cordova and Tatitlek will be offered a presentation in which they can review the data and its interpretation. Local knowledge from these members of the community, especially mariners and fishermen, will only enhance the data collected. In addition, the information gathered during the radar study will be loaded onto a compact disk, which can be copied and distributed to interested constituents. This CD will be offered to other communities as well, such as Chenga Bay, Nanwalek, Port Graham, Seldovia, Seward and Valdez.

PROJECT DESIGN

A. Objectives

1. Develop a plan to identify two separate sites for the deployment of the radar system. These sites will be selected to maximize observations of surface currents in the central sound and in Hinchinbrook Entrance, respectively.
2. Set up the radar for three weeks in each location and collect the data.
3. Process the data gathered.
4. Present the data with findings in a written report and verbal presentations to community members and other interested parties.

B. Methods

The HF-SWR radars are elongated structures comprising an array of 15 antenna, each 15 feet high. An array will be established at each site. In addition to setting up these arrays, computers to receive and store the data will be set up.

During deployment of the research equipment the investigators will be careful to minimize disturbance to fragile beach and terrestrial ecosystems.

AMT will be using students from the University of Alaska to assist in the research aspects of the project. These students will be paid to work on the project and will be expected to incorporate this activity into their own research. Dr. Cathy Connor in the Environmental Science Department of the University of Alaska Southeast will recommend students to participate in the project.

C. Cooperating Agencies, Contracts, and other Agency Assistance

Parties with an interest in the data yielded by the radar studies will include:
1. ADEC, interested in circulation and Hinchinbrook.
2. PWSSC, interested in the middle of the sound.
3. RCAC, interested in the area around Hinchinbrook.

SCHEDULE

A. Measurable Project Tasks for FY 02 (October 1, 2001 – September 30 2002)

March 5-10:	Travel to Prince William Sound to select site.
June 2:	Travel to Cordova with HF Radar
June 5:	Set up Radar on pre-selected site to measure mid sound.
June 6-29:	Collect data from the HR Radar
June 31- July 5:	Remove radar from site
July 9:	Move Radar to another pre-determined site.
July 11:	Set up Radar on pre selected site #2
July 12- August 3:	Collect Data from the HR Radar
August 4 – 8:	Remove Radar from site

B. Project Milestone and Endpoints

1. Selection of the sites
2. Completion of the first site and second site
3. Analysis of the data
4. Report completed

C. Completion Date

One year from being funded. Project will start October 1, 2001 and finish in September 30, 2002. Data will be analyzed in August, report will be written in September.

PUBLICATIONS AND REPORTS

The published data will be made available to researchers for use in their projects. The investigators will seek to publish their findings in professional journals, such as *Backscatter* (an official magazine of the Alliance for Marine Remote Sensing Association).

PROFESSIONAL CONFERENCES

The investigators will submit papers to relevant conferences and, if accepted, present the papers in person.

COORDINATION AND INTEGRATION OF RESTORATION EFFORTS

The data yielded by the proposed radar studies of Prince William Sound surface currents will be useful for other research projects that are underway and future projects to be undertaken. The Alaska Department of Environmental Conservation has expressed interest in obtaining information collected for Hinchinbrook Entrance, for possible application in tracking oil spills.

The data will be available to other organizations such as PWSSC and RCAC upon the request of the Exxon Valdez Oil Spill Trustees Council.

The project will be coordinated from Juneau, Alaska, with the assistance of students from the University of Alaska Southeast. Each study will take one week to set up, three weeks to collect data and four days to break down. Much of this will take place in the spring and summer..

PROPOSED PRINCIPAL INVESTIGATOR, IF KNOWN

Name: Alexander Kotlarov
Affiliation: (AMT)
Mailing Address: P.O. Box 33884
Phone Number: (907) 789-2476
E-mail address: amtcorp@lycos.com

PRINCIPAL INVESTIGATOR

Alexander Kotlarov, references to follow.

OTHER KEY PERSONNEL

1. Alexander Kotlarov, Project Manager (PI). Overall project management of the HF-SWR radar testing.
2. Des Powers, Director of Remote Sensing for C-CORE. Mr. Powers helped develop the (HF-SWR) and will be assisting with the project.
3. Senior Engineer, will be collecting data during the testing period.
4. Engineer III, will be setting up the sites and will be present during a portion of the testing period.
5. Engineer I, Student Intern provided by University of Alaska Southeast. Assist in site set up, site break down and collection of data.
6. Engineer I, Student Intern provided by University of Alaska Southeast. Assist in site set up, site break down and collection of data.
7. Engineer I, Student Intern provided by University of Alaska Southeast. Assist in site set up, site break down and collection of data.
8. Information Specialist. Develop and maintain the website for the project that will provide information about its progress, along with helping to compile all components of the study that are to be included on the informational CD-ROM.

*AMT is working on a proposal with Alaska Science and Technology Foundation to build a new state of the art HF-SWR current radar for the use of collecting surface current information. AMT does have a back up surface current radar available if the construction is not completed by the summer of 2002.

FY 02 *EXXON VALDEZ* TRUS COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002
Personnel		$49,000.0
Travel		$17,000.0
Contractual		$51,000.0
Commodities		$2,000.0
Equipment		$2,000.0
Subtotal	$0.0	$121,000.0
Indirect		
Project Total	$0.0	$121,000.0
Full-time Equivalents (FTE)		4083.3
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 2003					
$120,000.0					

Dollar amounts are shown in thousands of dollars.

Comments: This is the budget for two tests using a large array of anntenas that consist of over 15 anttenas and 2 computers. The budget includes the salaries of the Project Manager, two engineers from St. John Canada that are speicalist in HF radar data collection and three student interns. The set up of each site will take two days and the configeration of the computers will take two days. The Break down will take 4 days and moving to the next location will take two day.
Due to saftey we will have two team members at the site at all times. They will be dropped off by the charter boat and a camp will be made for the project team.

When the test is completed a final report will be produced and a CD rom will be made outlining the current informaiton collected.

FY02

Prepared:4/11/2001

Project Number: 02640
Project Title: High Frequency Surface Wave Radar Test in PWS.
Name: Alexander Kotlarov

FORM 4B
Non-Trustee
SUMMARY

FY 02 *EXXON VALDEZ* TRUS :OUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 2002
Project Manger	Project Manager		1	10000.0		10,000.0
Senior Enginee	Senior Engineer(From St Johns Canada)		1.0	14000.0		14,000.0
Engineer II	From St. Johns		1.0	13000.0		13,000.0
Intern	From University of Alaska Southeast		1.0	4000.0		4,000.0
Intern	From University of Alaska Southeast		1.0	4000.0		4,000.0
Intern	From University of Alaska Southeast		1.0	4000.0		4,000.0
						0.0
This budget is for two tests sites 3 weeks each plus set up and break down of the system.						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	6.0	49000.0	0.0	
					Personnel Total	$49,000.0

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FY 2002
						0.0
Field Investigation and site sellection		1000.0	2	5	200.0	3,000.0
Cordova from St. Johns, set up team (2 members)		1900.0	2	2	100.0	4,000.0
Cordova from Juneau, set up team (2 members)		400.0	2	2	100.0	1,000.0
Set up complete (2 members return, two stay for test)						0.0
Completion first half complete one members from St. Johns		1900.0	1	1	100.0	2,000.0
First half one member from Juneau replace		400.0	1	6	100.0	1,000.0
Completion first half complete one members from St. Johns returns		1900.0	1	1	100.0	2,000.0
Break down first test, two members arrive from Juneau		400.0	2	2	100.0	1,000.0
Set up for second test, two members return		400	2	2	100	1,000.0
completion first half, one member retrunes to St. John		1900.0	1	1	100.0	2,000.0
Completion of second test all members return (st. Johns and Juneau)						0.0
					Travel Total	$17,000.0

FY02

Prepared: 4/11/2001

Project Number:
Project Title: High Frequency Surface Wave Radar Test in PWS.
Name: Alexander Kotlarov

FORM 4B
Personnel
& Travel
DETAIL

FY 02 *EXXON VALDEZ* TRUS COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Contractual Costs:			Proposed
Description			FY 2002
High Frequency Surface Wave Radar rental	($700 a day)	42 days	30,000.0
Charter boat support (fast charter vessel 600 a day, large charter vessel 925 a day)			
Field Investigation and site selection	(fast charter boat 600 per day)		2,000.0
Load large charter boat			
Cordova to test site to off load radar		1 day	1,000.0
Set up on a pre selected site to measure mid sound and to set up camp.		4 days	4,000.0
Remove radar from site upon completion of site one		4 days	4,000.0
Move radar to second pre determined site and off load radar		2 days	2,000.0
Set up on pre-selected site to measure Hinchinbrook		4 days	4,000.0
Remove radar from site		4 days	4,000.0
		Contractual Total	$51,000.0

Commodities Costs:			Proposed
Description			FY 2002
Fuel	55 gallon drum		1,000.0
supplies for camp			1,000.0
Base camp supplies			0.0
		Commodities Total	$2,000.0

FY02

Prepared:4/11/2001

Project Number:
Project Title: High Frequency Surface Wave Radar Test in PWS.
Name: Alexander Kotlarov

FORM 4B
Contractual & Commodities DETAIL

FY 02 *EXXON VALDEZ* TRUS COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2002
			0 0
Generator	2	1000 0	2,000 0
Wall tent	1	0 0	0 0
Line	4	0 0	0.0
First Aid kit	1	0 0	0 0
			0 0
			0 0
			0.0
			0 0
			0 0
			0 0
			0.0
			0 0
Those purchases associated with replacement equipment should be indicated by placement of an R		**New Equipment Total**	$2,000.0

Existing Equipment Usage:	Number
Description	of Units

FY02

Prepared: 4/11/2001

Project Number:
Project Title: Title: High Frequency Surface Wave Radar Test in PWS.
Name: Alexander Kotlarov

FORM 4B
Equipment
DETAIL

Design of an Environmental Specimen Bank (ESB) Program for GEM

Project Number:	02643
Restoration Category:	Innovative Tools and Strategies to Improve Monitoring
Proposer:	NIST
Lead Trustee Agency:	DOI-USGS/BRD
Cooperating Agencies:	NIST, DOI-USGS/BRD
Alaska SeaLife Center	No
Duration:	12 months
Cost FY 02:	$85.4
Cost FY 03:	
Geographic Area:	Gulf of Alaska; GEM area
Injured Resource/Service:	All

ABSTRACT

This project will develop a design and implementation plan for an Environmental Specimen Bank (ESB) component to GEM specifically designed for environmental contaminants monitoring and research. This plan will provide organizational framework, facility requirements, identification of specimens of interest, collection and banking protocols, recommendations on specimen sizes and frequency of collections, establishment of database network with other kinds of archival facilities associated with GEM, recommendations on specimen access policy, identification and development of collection platforms (including partnership with local Native communities), and cost estimates for instituting and maintaining a ESB system for GEM.

INTRODUCTION

Environmental specimen banking (ESB) is the long-term preservation of representative environmental specimens (e.g., soil, sediments, air, water, and bio-materials) for deferred analysis (i.e., retrospective chemical analysis) and evaluation. A systematic well-designed specimen banking program enables future investigators to extend their research into the past (hind casting) and provides for future verification of analytical results (quality assurance).

Formal ESB has been recognized internationally as an integral part of long-term environmental monitoring (Wise and Koster, 1995; Iyengar and Subramanian, 1997). National ESB programs exist in Canada (Canadian Wildlife Service, National Wildlife Research Centre, Hull, Quebec), Germany (ESB for human specimens in Muenster and for other biota and the environment in Juelich), Japan (at the National Institute of Environmental Studies in Tsukuba), and in the U.S. (CDC Biorepository in Lawrenceville, GA, and the National Biomonitoring Specimen Bank [NBSB] at NIST in Gaithersburg, MD, and Charleston, SC). The national ESB programs of the Nordic countries are coordinated through the Nordic Council of Ministers and include the programs of Sweden, Norway, Finland, Denmark, Greenland, and Iceland. These national programs exchange information on protocols, equipment, and materials used in ESB through informal exchanges and international ESB conferences, such as the U.S. - German Seminars of State and Planning on Environmental Specimen Banking, International Symposia and Workshops on Biological Environmental Specimen Banking, and the annual meetings of the International Society for Biological and Environmental Repositories (ISBER).

Two national specimen bank programs in the U.S. are conducted at the CDC Biorepository (which maintains specimens for human health research) and at the NIST NBSB (which is designed for maintaining specimens for environmental research). Both of these programs include well developed banking protocols, computerized sample tracking (chain-of-custody) systems, maintenance of many forms of data associated with original specimens, and large investments in facilities and equipment required to store specimens over relatively long-periods of time. Emphasis for both programs has been placed on cryogenic storage, which makes use of both ultra-cold (< -80 °C) electric freezers and liquid nitrogen vapor storage (< -150 °C).

The NBSB of NIST has been involved in ESB since 1975. Originally started under sponsorship of EPA for the cryogenic banking of human liver specimens for contaminants monitoring, it was the specimen bank program used by NOAA's Status and Trends Program for the archival of sediments, fish tissues, mussels, and oysters from monitoring sites throughout the US (Wise and Koster,1995). It is the specimen bank program that is used by NMFS for the National Marine Mammal Tissue Bank, a specimen bank that was established by legislation in 1992 (Becker et al., 1999) and it was used by the Alaska Marine Mammal Tissue Archival Project (AMMTAP) for the development of collection protocols and the banking of tissues collected during Alaska Native subsistence hunts (Becker et al. 1988; 1993). The banking by the NBSB of marine mammal tissues collected by AMMTAP continues today and has resulted in a major resource of specimens that have been used for contaminants study and remain available for future retrospective analyses.

A new biotic material banked by the NBSB are seabird eggs collected as part of a collaborative project between USGS/BRD and USFWS to monitoring the levels of persistent organic

contaminants in Alaska Maritime NWR lands (York et al., 2001). In addition the NBSB is developing specimen banking procedures for marine animal blood and sea turtles, and is working with the Marine Genomics Consortium associated with The Hollings Marine Laboratory in Charleston, SC, to establish a cryogenic bank for marine genetic materials.

For environmental matrices collected for chemical analysis for anthropogenic contaminants, storage under cryogenic conditions is recognized as the best way to maintain the integrity of the samples for very long time periods (decades). The NBSB is expanding its ESB for marine monitoring and research into a new large cryogenic facility designed for 26 large liquid nitrogen vapor freezers (-150 °C) associated with a Class 100 clean room for handling and preparing aliquots of banked specimens for chemical analysis. This facility, which can be expanded for additional freezer storage space, is part of The Hollings Marine Laboratory, a laboratory designed for multi-disciplinary research on coastal and marine environmental health problems. Research in this institution range from analytical and environmental chemistry to research in the fields of biotoxins and the genomics of marine organisms.

The following items should be addressed when designing an ESB program (Wise and Koster, 1995):

1. First the relationship of the specimen bank effort to the environmental monitoring program should be clear, i.e., the banking should be considered as part of the monitoring program, not an afterthought or serendipitous effort.

2. Thought should be given to the statistical power required by the banking program and decisions on the representative number of specimens for each matrix-type should be made early in the program.

3. Specimens should be collected specifically for the bank using specific banking protocols(not as leftovers from the monitoring program).

4. Banked specimens should be collected at the same sites and time as samples collected for monitoring; this can result in cost reduction during sampling and provides a direct link to any real-time analytical monitoring data.

5. Specimen selection criteria should be established that takes into consideration: storage space limitations, sample size requirements, whether duplicate samples should be collected, what kinds of measurements are anticipated for the specimen, whether homogenous samples are necessary, whether the sampling technique can be repeated over time and over areas, and whether composite or individual specimens should be banked.

6. Special storage conditions to maintain the specimen over long time periods (years) must be considered and standard carefully designed protocols for collecting, storing, and processing samples must be developed to insure the integrity of the specimens.

7. A policy for access to the specimens must be developed and careful consideration given to the sample tracking system and associated databases required by the program.

NEED FOR THE PROJECT

A. Statement of Problem

ESB can be an important part of environmental monitoring, particularly for long-term monitoring programs. However, for maximum benefit, the specimen banking component must be designed early in the program (ideally before the program begins). In the formative stages of monitoring, a thorough survey and evaluation of existing repositories of specimens should be undertaken to determine if earlier collected materials are suitable for long-term banking for contaminants monitoring. Such collections can provide a resource that can extend the time line for the banking program into the past, as well as the future. It appears that FY02 is the ideal time to start the planning process that will link specimen banking to real-time monitoring in GEM. Through NIST's NBSB and agency programs that have supported it (i.e., Marine Mammal Health and Stranding Response Program (NOAA), Alaska Marine Mammal Tissue Archival Project (USGS/BRD), Sea Bird Tissue Archival Project (USGS/BRD & USFWS), Mussel Watch (NOAA), and the National Status and Trends Program (NOAA), environmental specimen banking protocols exist that can be applied to many of the EVOS injured resources, i.e., fish, shellfish, marine mammals, and seabirds.

B. Rationale/Link to Restoration

A well-designed ESB program for future retrospective studies can be an important component of both restoration and monitoring. If designed and implemented early in a long-term monitoring program, such as GEM, it can function as a strategy to improve real-time measurements by providing a resource for extending measurements into the past (hind casting) and will contribute to the quality assurance of monitoring data by allowing for future verification of analytical results.

C. Location

Gulf of Alaska; EVOS area

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

In addition to the banking of environmental specimens as subsets of collections from ongoing scientific monitoring studies, consideration will also be given to the banking of materials that may not be part of ongoing funded studies, but that can be obtained through involvement of local community participation. These may be specimens that are of particular interest to local Native subsistence life styles (subsistence food resources). The PI for the proposed work has extensive experience in enlisting the help of Alaska Native communities and organizations in another environmental specimen banking and monitoring program, AMMTAP. This program has been ongoing since 1987 and has involved communities as far ranging geographically as Barrow, Point Lay, Point Hope, Kotzebue, Nome, St. Paul, Nanwalek, New Chenega, and Tatitlek. AMMTAP has always emphasized feedback to the cooperating communities through their local organizations

and the incorporation of local traditional knowledge into the design and interpretation of the work. It is the intent that community involvement will be part of the design of any ESB program established for the GEM. This will be developed in consultation with the communities through their EVOS community facilitators and the Spill Area-Wide Coordinator.

PROJECT DESIGN

A. Objectives

By using the experience developed over the last 25 years by the NIST/NBSB in the areas of cryogenic specimen banking for environmental contaminants monitoring and research, as well as almost 15 years of experience in working with Alaska Native communities and organizations through AMMTAP, the objective of this proposed project is to design an ESB program for GEM.

B. Methods

Research and monitoring programs conducted in the Gulf of Alaska (GOA), both pre- and post-EVOS, will be reviewed through database searches, report reviews, telephone interviews, personal visits to research facilities, and a small workshop of selected researchers involved in specimen collections from the GOA, contaminants monitoring, and specimen banking to accomplish the following tasks: (1) identify the environmental matrices (biotic and abiotic) that will probably be pertinent to a GEM ESB; (2) identify and evaluate banked environmental specimens previously collected from the GOA; (3) determine collection and banking protocols that probably will be required by GEM; (4) define temporal frequency and geographical coverage of collections to be banked; (5) identify and describe facility requirements for ESB for GEM; (6) identify logistics/platforms suitable for collecting materials to be banked; and (7) produce an implementation plan for the GEM ESB.

1. Identify the environmental matrices (biotic and non-biotic) pertinent to GEM. Although one cannot be exactly sure of all the environmental specimens that will be collected for research and monitoring purposes during GEM, based on the kinds of specimens collected during EVOS Restoration Program, as well as the kinds of materials that have been collected by other large-scale research/monitoring programs in Alaska and in other regions, one can develop a list that probably covers the majority of materials that are candidates for an ESB. For some of these, such as surface sediments, sediment cores, mammal and bird tissues, fish, and shellfish, protocols exist for collection and banking for contaminant analysis and are probably directly applicable to the GEM ESB.

2. Review and evaluate environmental specimens previously archived from the GOA. Existing archived/banked material from the GOA that might be suitable for obtaining and retaining as part of the GEM ESB will be identified. Programs that have collected and archived specimens include the EVOS Damage Assessment and Restoration programs, Outer Continental Shelf Environmental Assessment Program (OCSEAP), AMMTAP, STAMP, National Status and Trends Program, Mussel Watch Program, as well as various programs conducted by resource agencies (ADFG, NMFS, DOI-FWS) and universities (University of Alaska), to name just a few.

Specimens will be evaluated as to their present conditions in storage and future conditions if maintained within their present storage environment, whether they have adequate data and information to support their integrity as future monitoring resources (is there enough data associated with the specimen that will allow for interpretation of future chemical analyses?). In some cases, ESB for long-term monitoring may require that presently archived specimens should be sub sampled, repackaged, and sub samples (or whole specimens) transferred to other storage conditions to insure that the sample remains stable enough for future chemical analyses. Recommendations will be developed on how to handle such collections. Some monitoring/specimen banking projects are presently active in Alaska (AMMTAP, STAMP, Harbor Seal Monitoring Program, Sea Otter Monitoring Program). Consideration will be given to the feasibility of expanding the specimen archiving component of these within the GAO and EVOS area.

3. Determine collection and banking protocols that will be required by GEM. Based on Task 1, above, and existing knowledge on collecting and banking protocols used by various ESB programs (both within the U.S. and in foreign countries), protocols required by a GEM ESB will be determined and described. Some protocols already exist and can be incorporated into a GEM ESB. For some kinds of specimens, protocols may not exist and will have to be developed.

4. Define temporal frequency and geographical coverage of collections to be banked. Although this may not be fully developed until after GEM actually begins, some information from other monitoring/banking programs (including data from the EVOS Damage Assessment and Restoration programs) is available that should aid in the development of preliminary recommendations for the number of specimens of each kind to be banked, the frequency, and geographical coverage from monitoring projects in GEM for certain kinds of matrices (sediments, fish tissue, marine mammal tissues, etc.) and certain kinds of measurements (PCBs, heavy metals, chlorinated pesticides, etc.). This is a task that will require extensive discussion among selected researchers in a workshop setting.

5. Identify and describe facility requirements for the ESB. Although there are numerous facilities that store or bank specimens (i.e., museums, agency wildlife and fish research facilities, university research departments, and centralized national research depositories), there are probably none that are designed to bank all materials for all possible kinds of research. ESB for contaminants monitoring requires cryogenic storage conditions and associated clean room facilities for specimen handling and preparation for analyses. Many facilities utilizing ultra-cold electric freezers (-80 °C) have the capability for relatively short-term storage (a few years), but few have the capability for maintaining storage for many decades (or centuries as is proposed for GEM). Consideration has to be given to existing infrastructure and resources (facilities, personnel, equipment, database capabilities for specimen tracking), the potential for expansion, and the ability of the repository to make a long-term commitment to GEM.

6. Identify logistics/scientific platforms for collecting materials to be banked. Potential platforms include planned scientific cruises, shore-based sample collections by agency and research organization surveys, and subsistence activities by local Native communities. Shipboard procedures for collecting specimens to be banked and the logistics requirements to handle such collections can be substantially different from what is required for shore-based collections and

collections from subsistence activities. All such platforms have been used in the past for collections of biota and sediment for banking; therefore, there are existing procedures that can be adapted for specific local situations. An important means of obtaining specimens will be through working with local Native communities to obtain specimens for subsistence harvests. Through this local involvement, individual and organizations are trained in the specimen collection protocols and they work as partners in the program. This requires regular and timely feedback to the participating communities and a willingness to incorporate local knowledge, when it is offered, into the database associated with this specimen collection.

6. Produce a GEM ESB implementation plan. Based on the results of the Tasks 1 - 5, an implementation plan will be developed for instituting a formal ESB component for GEM. This will include recommendations regarding specimen types, collection and banking protocols (including those that need to be developed), frequency and geographical coverage, specific platforms for collections, facility requirements, specimen tracking databases and links to other databases on specimen collections in the GOA, existing collections that should be included in the ESB, and identification of ongoing monitoring/specimen banking projects that should be expanded into the EVOS area. In addition, the implementation plan will provide recommendations on mechanisms by which all monitoring activities funded by GEM Program can contribute to the ESB. An important part of this implementation plan will be the drafting of a recommended specimen access policy to guide the release of specimens in the future for monitoring and research. A scope of work for an ESB program with a first-year budget and muti-year time line will be provided to GEM

C. Cooperating Agencies, Contracts, and Other Agency Assistance

DOI-USGS, Biological Resources Division, Alaska Biological Science Center

Department of Commerce, National Institute of Standards and Technology

SCHEDULE

A. Measurable Project Tasks for FY 02 (October 1, 2001 - September 30, 2002)

October 1 - May 31:	Review of previously archived specimens and ongoing research/monitoring programs
October 1 - June 30:	Identify specimen matrices pertinent to GEM
March:	Conduct workshop
November1 - July 31:	Review and evaluation of collection platforms
October 1 - September 30:	Coordination with local Native communities
January 1 - August 31:	Determine collection and banking protocols required by GEM
January 1 - August 31:	Develop facility requirements description
July1 - September 30:	Develop ESB implementation plan.

B. Project Milestones and Endpoints

Conduct workshop	March 2002
Complete review of archived specimens and ongoing programs	May 31, 2002
Complete identification of specimen matrices for ESB	June 30, 2002
Complete review and evaluation of collection platforms:	July 31, 2002
Complete determination of required collection and banking protocols	August 31, 2002
Complete description of ESB facility requirements	August 31, 2002
First draft of the GEM ESB implementation plan	October 1, 2002

C. Completion Date:

The project will be completed on October 1, 2002

PUBLICATIONS AND REPORTS

The final report will be a design and implementation plan for an Environmental Specimen Bank (ESB) component to GEM, that is specifically designed for environmental contaminants monitoring and research.

PROFESSIONAL CONFERENCES

A presentation on the development of an ESB for the GEM Program will be presented at the annual meeting of the International Society for Biological and Environmental Repositories (ISBER), which will probably be held in the spring of 2002.

NORMAL AGENCY MANAGEMENT

The development and implementation of ESB programs are normally conducted by the cooperating agencies through funding from other agencies requesting technical support for existing or planned monitoring programs.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Since the tasks of this project will involve the gathering of information pertinent to the design of a monitoring tool for GEM, coordination and information exchange with most of the EVOS Restoration Program funded projects will be required. The project will also coordinate with other

agencies (NOAA, ADFG, ADEC, DOI-FWS, DOI-NPS, Alaska Native Tribal Health Consortium) and academic and research institutions (e.g., University of Alaska Museum, Alaska SeaLife Center) that have ongoing research and monitoring programs applicable to a GEM ESB. Local community involvement, which is an important component of this planning and design project, will also require coordination with the EVOS community facilitators and the Spill Area-Wide Coordinator.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

This is a new proposal for new work, not a continuing project

PROPOSED PRINCIPAL INVESTIGATOR

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Charleston, SC 29412
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paul_becker@nist.gov

PRINCIPAL INVESTIGATOR

Paul R. Becker, Ph.D., is a Research Biologist and NIST Charleston Project Leader, with overall responsibility for implementing the National Marine Analytical Quality Assurance Program at the NIST Charleston Laboratory. This program includes expanding the National Biomonitoring Specimen Bank (a cryogenic ESB facility) for marine monitoring and research through the development of a new large cryogenic specimen bank facility within The Hollings Marine Laboratory in Charleston. He has more than 25 years of experience working in Alaska, first with the Outer Continental Shelf Environmental Assessment Program, then with NMFS, and finally with NIST. He has extensive field experience in Alaska, particularly working with Alaska native communities and individuals in the collection of environmental specimens for contaminant analysis and specimen banking. He originally led the development of AMMTAP (which began in 1987) as a tissue specimen banking and analytical program for Alaska marine mammals, and was one of the principal developers of STAMP, a program for the monitoring of contaminants in Alaska colonial seabirds and the banking of seabird tissues.

OTHER KEY PERSONNEL

Geoff W. York, Research Biologist and USGS/BRD lead for AMMTAP and STAMP, will be the local Alaska contact for the project, providing local expertise in surveys of databases and local programs pertinent to the project. He will be involved in the set up and conduct of a local workshop as part of the planning process and will provide expertise in developing the implementation plan.

Barbara J. Porter, Research Biologist and NIST Gaithersburg leader for specimen banking, will provide expertise in the evaluation and development of collection and banking protocols.

Rebecca S. Pugh, Research Biologist and NIST Charleston leader for specimen banking, will provide expertise in specimen banking procedures, including specimen databases, and clean room operations associated with banking facilities.

Stephen A. Wise, Ph.D., NIST Gaithersburg, Organic Analytical Methods Group, was one of the original designers of the National Biomonitoring Specimen Bank and has 25 years of experience in environmental specimen bank design. He will provide expertise in specimen banking

requirements for analytical chemistry.

LITERATURE CITED

Becker, P.R., B.J. Koster, S.A. Wise, R. Zeisler. 1993. Biological specimen banking in Arctic research: an Alaska perspective. *Sci. Total Environ.* 139/140: 69-95.

Becker, P.R., S.A. Wise, B.J. Koster, and R. Zeisler, "Alaskan Marine Mammal Tissue Archival Project: A Project Description Including Collection Protocols," NBSIR, 88-3750, National Bureau of Standards, Gaithersburg, MD. 46 p. (1988).

Becker, P.R., B.J. Porter, E.A. Mackey, M.M. Schantz, R. Demiralp, S.A. Wise. 1999. National Marine Mammal Tissue Bank and Quality Assurance Program: Protocols, Inventory , and Analytical Results. NISTIR 6279. National Institute of Standards and Technology, Gaithersburg, MD. 183 p.

Iyengar, G.V., and K.S. Subramanian, K.S. 1997. Environmental Biomonitoring and Specimen Banking: Bioanalytical Perspectives. In: *Environmental Biomonitoring: Exposure Assessment and Specimen Banking*, K.S. Subramanian & G.V. Iyengar, editors. ACS Symposium Series 654, American Chemical Society Books, Washington, DC. 23:1-16.

Wise, S.A., and B.J. Koster. 1995. Considerations in the design of an environmental specimen bank: experiences of the National Biomonitoring Specimen Bank Program. *Environ. Health Perspec.* 103:61-67.

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$5.5						
Travel		$0.0						
Contractual		$73.9						
Commodities		$0.0						
Equipment		$0.0						
Subtotal	$0.0	$79.4	Estimated FY 2003					
General Administration		$6.0						
Project Total	$0.0	$85.4						
Full-time Equivalents (FTE)		0.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources	$54.2							

Comments:

FY02

Prepared: April 12, 2001

Project Number: 02643
Project Title: Design of an Environmental Specimen Bank Program for GEM
Agency: USGS

FORM 3A
TRUSTEE
AGENCY
SUMMARY

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Personnel Costs:						
Name	Position Description	GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Proposed FY 2002
G. York	Research Biologist	GS/11/1	1.0	5.5		5.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		1.0	5.5	0.0	
					Personnel Total	$5.5

Travel Costs:					
Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 2002
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY02

Prepared: April 12, 2001

Project Number:
Project Title: Design of an Environmental Specimen Bank Program for GEM
Agency: DOI-USGS, Biological Resources Division

FORM 3B
Personnel
& Travel
DETAIL

FY 02 *EXXON VALDEZ* TRUS[illegible] COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Contractual Costs:	Proposed FY 2002
Description	
4ab Linkage: Contract to the National Institute of Standards an Technology, CSTL, Gaithersburg, MD, to provide services and expertise required for information review, evaluation of scientific protocols, evaluation of cryogenic specimen banking facility requirements, and conduct of workshop to develop design and implementation plan for an ESB for GEM	74.5
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$74.5

Commodities Costs:	Proposed FY 2002
Description	
Commodities Total	$0.0

FY02

Prepared: April 12, 2001

Project Number:
Project Title: Design of an Environmental Specimen Bank Program for GEM
Agency: DOI-USGS, Biological Resources Division

FORM 3B
Contractual & Commodities DETAIL

FY 02 *EXXON VALDEZ* TRU[illegible]E COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2002
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY02

Prepared: April 12, 2001

Project Number:
Project Title: Design of an Environmental Specimen Bank Program for GEM
Agency: DOI-USGS, Biological Resources Division

FORM 3B
Equipment
DETAIL

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002	LONG RANGE FUNDING REQUIREMENTS					
			Estimated FY 2003					
Personnel		$34.9						
Travel		$28.6						
Contractual		$1.2						
Commodities		$1.0						
Equipment		$0.0						
Subtotal	$0.0	$65.7						
Indirect		$8.2						
Project Total	$0.0	$73.9						
Full-time Equivalents (FTE)		0.5						
	Dollar amounts are shown in thousands of dollars.							
Other Resources	$54.2							

Comments: Indirect costs are 25% of the first $25 K of direct costs + 5% of $41.2 K of direct costs. Other resources include salary and overhead/benefits costs for an additional month of Becker's time, 0.5 month of Wise's time, additional overhead/benefits cost of Pugh, and Porter and additional travel required by the project. These additional resources are handled through NIST internal funding (total contribution = $54.2 K) and will not be charged to the project.

$1.0K of the project costs is for report writing and printing.

Travel and contractual costs are for a workshop in Anchorage (room rental + invitational travel for 26 people which includes perdiem for a 2.5 day period). Additional travel on the project will be handled through internal funding and will not be charged to the project. This amounts to $4.6K.

FY02

Prepared: April 12, 2001

Project Number:
Project Title: Design of an Environmental Specimen Bank Program for GEM
Name: NIST

FORM 4A
Non-Trustee
SUMMARY

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 2002
P. Becker	Research Biologist		3.0	7.9		23.7
R. Pugh	Research Biologist, Specimen Bank		1.5	3.8		5.7
B. Porter	Research Biologist, Specimen Bank		1.0	5.5		5.5
S. Wise	Supervisory Analytical Chemist		0.5	0.0		0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		6.0	17.2	0.0	
					Personnel Total	$34.9

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FY 2002
Travel for 26 Workshop Participants with average round-trip plane ticket cost of $600 per individual		0.6	26	65	0.2	28.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$28.6

FY02

Prepared: April 12, 2001

Project Number:
Project Title: Design of an Environmental Specimen Bank Program for GEM
Name: NIST

FORM 4B
Personnel
& Travel
DETAIL

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Contractual Costs:	Proposed FY 2002
Description	
1 Rental of meeting room for workshop (3 days)	1.2
Contractual Total	$1.2

Commodities Costs:	Proposed FY 2002
Description	
1 Report preparation and printing	1.0
Commodities Total	$1.0

FY02

Prepared: April 12, 2001

Project Number:
Project Title: Design of an Environmental Specimen Bank Program for GEM
Name: NIST

FORM 4B
Contractual & Commodities DETAIL

FY 02 *EXXON VALDEZ* TRU[illegible]LE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2002
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	

FY02

Prepared: April 12, 2001

Project Number:
Project Title: Design of an Environmental Specimen Bank Program for GEM
Name: NIST

FORM 4B
Equipment
DETAIL

Molecular Biomarkers as a New Technique for Assessing Physiological Contaminant Stress

Project Number:	~~To be assigned~~ 02644
Restoration Category:	Research, Monitoring
Proposer:	NOAA/NOS/Office of Response & Restoration Hazardous Materials Response Division Seattle, Washington
Lead Trustee Agency:	NOAA/OR&R
Cooperating Agencies:	NOAA/CCEHBR
Alaska SeaLife Center:	No
Duration:	1-year project
Cost FY 01:	$114.1
Geographic Area:	Prince William Sound, Lower Cook Inlet
Injured Resource/Service:	Intertidal Communities; Commercial Fishing

ABSTRACT

This project has two primary objectives: first, a targeted evaluation/validation of a new monitoring technology (based on the measurement of a series of molecular biomarkers) to assess extent and source of biological stress; and second, the linking of stress in mussels inhabiting small boat harbor areas in Prince William Sound and Lower Cook Inlet to contaminant type (i.e., fuel oils or antifouling paint components. The monitoring tool has the potential for application beyond this specific setting (and particularly as a transitional bridge to GEM), but the work as proposed will provide useful information on the biological status of mussels residing in six small boat harbors in Prince William Sound and Lower Cook Inlet.

INTRODUCTION

One of the significant lessons learned over the ten-year course of NOAA/OR&R s Prince William Sound Long-Term Intertidal Monitoring Program has been the difficulty in linking contaminant exposure to specific biological consequences. That is, we have readily documented the bioavailability of residual oil, but have experienced much greater difficulty in interpreting biological effects of those hydrocarbons especially direct effects as opposed to indirectly inferred impacts. Earlier attempts to link tissue burdens with biological parameters of resident organisms (histology, blood cell responses) were equivocal at best.

In the NOAA/OR&R monitoring effort, samples of mussels and clams have been routinely collected and chemically analyzed as indicators of the biological availability of petroleum hydrocarbons in the spill-affected region. Results of those analyses have shown that tissue levels of polynuclear aromatic hydrocarbons at oiled beaches we surveyed declined sharply in the first few years following the spill. Currently, tissue concentrations at oiled study sites in both mussels and clams are not statistically different from those at unoiled locations.

Despite this observation, we are well aware that heavier oiling remains at specific places in Prince William Sound, and that at those locations, resident biota such as mussels and clams contain elevated concentrations of hydrocarbons in their tissues. Because of this, in addition to the fixed group of sites we have monitored for more than ten years, we also have sampled other sites of interest one or more times. This latter group includes some of the more heavily oiled locations.

We also have collected mussels from the small boat harbors where our charter vessels have been based. Previous experience with bivalve-based monitoring programs had suggested that organisms from these locations could represent a kind of positive control for fuel-related hydrocarbon contamination due to chronic nonpoint source spills and leakages associated with small boat activities. Results of our chemical analysis for marinas in Whittier, Seward, and Cordova confirmed this assumption, with samples from the small boat harbors substantially exceeding levels obtained at oiled sites in the Sound.

In the year 2000, we began a collaboration with the NOAA Center for Coastal Environmental Health and Biomolecular Research (Charleston, SC) and Envirtue Biotechnologies, Inc. (Harrisonburg, VA) to evaluate a new approach to environmental assessment. In cooperation with NOAA/CCEHBR, Envirtue Biotechnologies has developed and refined a system for the analysis of environmental samples to determine physical and biological stressors in plants and animals. This system, the Downs Molecular Biomarker System (DMBS), integrates cellular and molecular biology with ecology and environmental science. An application of the approach in a coral reef system is described in Downs et al. (2000). DMBS examines the health of an organism by detecting changes at the molecular and cellular levels that reflect responses of known physiological significance. In this way, DMBS allows for the determination of:

- ¥ physiological stress;
- ¥ acclimation or adaptation in response to a chronic stress; and
- ¥ cellular responses that are specific to a particular stressor (e.g., aromatic hydrocarbons or other chemicals).

DMBS relies on substantial recent advances in biomedical technology and science. Through its assays, the system can detect the presence and concentration of specific proteins and cellular

molecules that are physiologically relevant to the health of a particular organism. DMBS uses a wide array of assays specific to different species, and an automated high-throughput system processes and analyzes in days or weeks samples that would otherwise take months or years.

In 2000, NOAA/OR&R incorporated sample collection for analysis by DMBS into the final regular field sampling program under its long-term monitoring program. Mussel and clam tissues were collected from oiled and unoiled areas; mussels were also collected from Cordova Harbor. The cellular parameters chosen for analysis included:

:

- Benzo[a]pyrene diol epoxide adducted with protein (BPDE);
- carbonyl (protein carbonyl);
- copper/zinc superoxide dismutase (Cu/Zn SOD);
- cytochrome P450 2E immuno-homologue (CYP P450);
- glutathione peroxide (GPx);
- glutathione-S-transferase (GST);
- 4-hydrone-2E-nonenal (HNE);
- heat-shock protein 60 (Hsp60);
- heat-shock protein 70 (Hsp70);
- heat-shock protein 90 (Hsp90);
- malondialdehyde (MDA);
- manganese superoxide dismutase (MnSOD);
- total small heat-shock protein isoforms (sHsp);
- ubiquitin.

Results from this pilot study showed distinct differences in levels of cellular stress indicators in mussels from oiled and unoiled sites, and unique responses in the small boat harbor relative to the other sites. Based on the preliminary results, we believe the approach holds considerable promise as a monitoring tool and submit this proposal to focus and refine validation of the method.

In performing this work in the small boat harbors of Prince William Sound (Cordova, Valdez, Whittier, Seward) and Lower Cook Inlet (Homer, Seldovia), we will also gain excellent information on the physiological status of resident mussels that can define baseline health status of the individuals and sources of stress. This background can then be used in the future to determine if source control efforts and other corrective strategies in the harbors (currently being encouraged by OSRI, among others) are reducing biological stress.

NEED FOR THE PROJECT

A. Statement of Problem

The proposed work addresses two very different kinds of problems. First, validation of the approach will further an understanding of the biological relevance of tissue chemistry. By permitting us to link tissue concentrations of contaminants to biological consequences, cellular approaches like DMBS provide the scientific basis for answering the how clean is clean? question that arises at all spills. They also potentially provide a way to isolate stresses attributable to a spill or other disturbance from those unrelated to such incidents, and thus can

represent a much more meaningful baseline measurement against which future changes can be assessed.

Unlike many of the other approaches that have been used to link exposure to impact, the molecular biomarker technique can be adapted (with the selection of appropriate assays) to provide physiological stress information across the spectrum of biota, from plants to marine mammals. Because it is clear that oil and other environmental contaminants affect different species in different ways, over time the accumulation of data in a wide range of biota will permit the identification of more sensitive or at-risk components of the ecosystem.

In addition to a pilot project in FY00 initiated under the auspices of NOAA/OR&R s long-term monitoring program, the molecular biomarker approach is also being incorporated into the Olympic Sanctuary s research and monitoring program to assess current biological condition of selected organisms as well as provide a baseline against which future impacts can be quantified.

B. Rationale/Link to Restoration

As the transition is made from Restoration to GEM, the value of a biological framework within which to interpret chemistry results is only increased. The combination of chemistry and molecular biomarkers provides a powerful tool for evaluating exposure to contaminants and stress induced by other environmental parameters, as well as the biological significance of that exposure. In the Restoration Program, we continue to evaluate impact from the Exxon Valdez spill; in Gulf Ecosystem Monitoring, we are interested in assessing present status and large-scale changes. The molecular biomarker approach provides a natural bridge between the two programs since it can be used for both purposes.

C. Location

Sample collections of mussels will occur in the small boat harbors of Cordova, Valdez, Whittier, Seward, Seldovia, and Homer. Reference samples will be collected in Kasitsna Bay and an undetermined location in Prince William Sound. Molecular biomarker analyses will take place at Envirion Biotechnologies in Clayton, CA. Chemical analysis for hydrocarbons and metals will occur at Louisiana State University in Baton Rouge, LA.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

The results of this project will be of interest to the operators and users of the small boat harbors in the Sound and Lower Cook Inlet, and certainly would be relevant to the Prince William Sound Oil Spill Recovery Institute (OSRI) as it implements its grants program related to small spills. We propose to share study results with OSRI and harbormasters of all sampled harbors so that they can compare conditions in the six marinas and possibly use the results as one baseline to measure performance improvements in reducing contamination. In Cook Inlet, the Cook Inlet Keeper and the Cook Inlet Regional Citizens Advisory Council will additionally be provided with updates and reports of results. Alaska Sea Grant extension agents also will receive project reports. NOAA personnel will be available to brief local and regional groups on the implications of project results.

PROJECT DESIGN

A. Objectives

The objectives of the proposed study are to correlate exposure of mussels to cellular measures of stress in several areas known to receive chronic inputs of fuel-related hydrocarbons and possibly metals related to the use of vessel antifouling paints. Field results will be compared to results from laboratory challenges to calibrate the responses and fine tune interpretation to specific stressors. The project will serve to further define how to apply cellular and molecular technologies to relevant environmental assessment.

B. Methods

Field collection methods are relatively simple and straightforward, although some field processing and access to low-temperature storage will be necessary. Laboratory methods for molecular assays, chemical analysis, and laboratory challenges are relatively complex and are summarized below.

Field Collections

At each of the eight designated sampling locations, 70 resident mussels (*Mytilus trossulus*) will be collected. Ten individuals will be randomly selected from the aggregated sample and reserved as the molecular biomarker sample. The remaining 60 mussels will be randomly separated into two samples of 30 individuals each. One of these composites represents the hydrocarbon chemistry sample, the other the metals chemistry sample.

The ten individuals selected for biomarker analysis will be shucked in the field with the tissues placed in labelled individual cryogenic vials and held in liquid nitrogen dry shippers.

Chemistry composites will be wrapped in aluminum foil and placed in labelled ziplock bags. These will be placed on ice until they can be frozen at —20¡ C.

Molecular Biomarker Laboratory

Sample preparation

Mytilus trossulus frozen in liquid nitrogen will be ground in liquid nitrogen to a fine powder using a mortar and pestle, and then suspended in a denaturing buffer. Samples will be vortexed for 30 seconds, incubated at 85...Cfor 5 min, re-vortexed, and then centrifuged at 10,000 *x g* for 5 min. Total soluble protein concentration of samples are to be assayed by the method of Ghosh et al. (1988).

ELISA and densitometric analysis

Samples are assayed for the selected cellular parameters using EnVirtue Biotechnologies, Inc. proprietary ELISA-based immunochemical analysis with a chemiluminescent reporter system. All samples will be analyzed in triplicate.

Once developed, blots are scanned into a computer and analyzed using NIH image analysis software (http://rsb.info.nih.gov/nih-image). A serial dilution of purified protein for each cellular parameter is included in each assay to allow sample quantification and assay quality control. Concentration standards for each assay are determined, and a quadratic or polynomial equation used to determine the concentration of each sample.

Chemistry Laboratory: Aromatic Hydrocarbons

Tissue hydrocarbon analyses will be performed at Louisiana State University. Methods are modified from the procedures of Krahn et al. (1988). Tissues from a given site will be extracted from shells, thoroughly rinsed with deionized water, and composited. The composite samples are homogenized in a blender and refrigerated in solvent-rinsed jars with Teflon¤-lined caps before further sample preparation. If delay of more than two days is anticipated, the samples are frozen. For analysis, a small aliquot, 3 to 5 g, of the homogenized tissue is added to 40-ml precleaned and solvent-rinsed vials. The samples are digested overnight by adding a single pellet of potassium hydroxide. To enhance the digestion, the samples are sonicated and swirled periodically. The samples are then spiked with a surrogate standard suite. The samples are dried with anhydrous sodium sulfate until the consistency of dry sand is attained and then these are extracted three times with dichloromethane. The extracts are combined into a single rotary-evaporation flask and reduced to less than 4-ml volume. At this time, the sample extract is transferred into 4-ml vials and reduced in volume further by nitrogen blow-down. The solvent is exchanged into hexane and reduced to 100 l.

Sample fractionation, or cleanup, is required to enrich the target analytes while at the same time excluding matrix interferences. Sample fractionation is performed using silica-gel/alumina columns. The columns are calibrated to elute the desired analytes from the column in the aromatic fraction. This fraction is eluted into conical 4-ml volumetric vials and reduced to a final extract volume of 0.1 ml before instrumental analysis. The target analytes are quantified by an internal standard method and corrected for recovery using surrogate standards.

Dry weights are determined by weighing a small amount of the homogenized tissue on a pre-conditioned, pre-numbered, and pre-weighed tin. The tin is placed into a drying oven at 90ßC for 24 hours, then re-weighed.

Chemistry Analysis: Metals

Tissue metals analyses will be performed at Louisiana State University. Two metals will be targeted in this project: copper and tin, because of their roles in active ingredients in vessel antifouling paints. Methods to be used will be adapted from those of the National Status and Trends Program (Lauenstein and Cantillo, 1993).

Laboratory Challenge Experiments

The response of *Mytilus trossulus* to diesel oil water-accomodated fractions, copper and tin stressors will be evaluated in laboratory challenge experiments. Specifically, the mussels will be acclimated and grown in the laboratory under optimal growth conditions (determined by preliminary experiments). Once acclimated, 5 individuals per treatment will undergo separate acute (24 h) challenges to each type of stressor: (1) water-accommodating fraction of diesel fuel, (2) copper and (3) tin. We plan to used 3 ecologically relevant concentrations of each chemical

stressor in these studies. For copper, a range of 0.2-500ug/L are found in marine waters, for tributyltin we expect to use 2ng/L -100ng/L and for the water accommodating fraction of diesel fuel we plan to use 1ug/L-100ug/L. Organisms will be harvested and tissue immediately frozen at -80°C after exposures. Frozen tissues are processed by grinding in a chilled mortar and pestle into a fine powder and then suspended in a solubilization solution. Samples are vortexed and centrifuged to remove insoluble materials. Supernatant is placed in a new tube for sample analysis. Protein concentration of samples are assayed by method of Ghosh et al., 1988. Samples are assayed for the suite of relevant biomarkers using immunochemical analysis. All samples will be done in triplicate. Cellular parameters (biomarkers) assayed are run against standards. Dilutions of each standard is used to develop a standard curve for each assay and determine the concentration of each test sample.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

This represents a collaborative effort between NOAA/OR&R and NOAA/CCEHBR to refine, validate, and apply a new technology to real environmental problems. NOAA/CCEHBR has played a critical role in development of the technologies to be used and understands the capabilities and limitations of the approach, while NOAA/OR&R has extensive experience in defining critical issues in monitoring impact and recovery. We will also solicit the advice and support of the Kachemak Bay National Estuarine Reserve to determine the best sampling location for one of our two reference sites.

Personnel and project management

The project will be implemented by an experienced team of scientists who have been directly involved in intertidal research, monitoring studies, and biomolecular. The work will be coordinated by NOAA/Office of Response & Restoration, with Gary Shigenaka as the project leader.

Responsibilities for each of the participating offices is as follows:

NOAA/Office of Response & Restoration Seattle, WA (Shigenaka)
- Overall project management
- Field sampling
- Assist in data analysis
- Co-author on manuscripts

NOAA/Center for Coastal Environmental Health and Biomolecular Research Charleston, SC (Woodley)
- Laboratory challenges
- Primary contact for laboratory work
- Co-author on manuscripts

Envirion Biotechnologies Clayton, CA (Downs)
- Contracted molecular biomarker analytical support
- Co-author on manuscripts

Louisiana State University Baton Rouge, LA (Miles)
- Contracted chemistry support

University of Charleston Charleston, SC (Fauth)
Subcontracted biological support
Lead for statistical analysis
Co-author on manuscripts

SCHEDULE

A. Measurable Project Tasks for FY 02 (includes FY03 carryover tasks from FY02)

Field sampling will be conducted in February 2002; laboratory analysis will commence March and April 2002; data analysis will take place in August, 2002. A progress report will be prepared at the end of FY02 (September 2002), with the final report to be completed by the end of December, 2002.

B. Project Milestones and Endpoints (includes FY02 carryover tasks from FY01)

All field work will be completed by March, 2002. The final report for the work will be complete by the end of calendar 2002.

October 1, 2001:	Project initiation
November 2001	PI project planning meeting
January 2002	Trustee workshop, Anchorage
February 28, 2002:	Field sampling in PWS and Lower Cook Inlet completed
March-April, 2002:	Begin laboratory analyses (chemistry & biomarkers)
August 1, 2002	Laboratory analyses complete, begin statistical analysis
September 2, 2002	PI meeting, location TBD
September 30, 2002:	Progress report/report draft
December 31, 2002:	Final project report completed

C. Completion Date

It is anticipated that the project will be completed by December 2002.

PUBLICATIONS AND REPORTS

The final report for the project will be issued as a NOAA Technical Memorandum. It is also our intent to submit the results of this experiment to a peer-reviewed journal for publication, to be determined at a later date.

PROFESSIONAL CONFERENCES

No funding is being requested for attendance at professional conferences in FY02. Funding for conferences following the completion of the project and interpretation of results may be solicited from supporting agencies in FY03.

NORMAL AGENCY MANAGEMENT

With the end of NOAA/OR&R s long-term monitoring program in Prince William Sound, there is no mechanism for HAZMAT to pursue further research to refine and apply new monitoring

techniques. However, additional methodological validation will encourage incorporation of molecular biomarker approaches into impact assessment and baseline monitoring for response, NRDA, and restoration purposes.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This is a relatively straightforward sampling and analytical program, but there is potential for collaboration with universities or other agencies that may wish to add other measures of biological effect (such as histopathology) to correlate with cellular assays. We would encourage this. Similarly, if researchers have an interest in tissue chemistry analytes beyond the targeted PAHs, aliphatics, and metals, it would be relatively easy (with modest additonal funding) to expand the suite of results. Finally, the OSRI will be invited to accompany the field team during sampling of small boat harbors so that an understanding of the project is encouraged and to facilitate outreach concerning source control in each location.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

None

PROPOSED KEY INVESTIGATORS

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BIOGRAPHICAL SKETCHES FOR PRINCIPAL INVESTIGATORS

Gary Shigenaka is the proposed principal investigator for this project. A graduate of the University of Washington s School of Oceanography (1976) and Institute for Marine Studies (1987), he was part of NOAA s initial *Exxon Valdez* damage assessment team in 1989 and since 1991 has managed NOAA s long-term monitoring program in Prince William Sound. He has been a principal field scientist in every project monitoring visit to the Sound save one, when his son was born in 1995. He has extensive experience in fisheries biology, oceanography, and environmental monitoring. Prior to joining NOAA/HAZMAT in 1990, Mr. Shigenaka worked on the National Status and Trends Program in Washington, DC and Seattle.

Cheryl Woodley is a NOAA co-principal investigator for the project. She is a graduate of Winthrop College (B.A. biology, 1977) and the Medical University of South Carolina (Ph.D., molecular & cellular biology & pathobiology, 1984). Dr. Woodley has directed research at NOAA s Center for Environmental health and Biomolecular Research biotechnology program since 1998, and, with Craig Downs, initiated projects to develop technologies based on cellular and biochemical principles and methods to address estuarine and marine ecological issues (e.g., coral bleaching, coral disease, molecular biomarkers).

Craig A. Downs is a co-principal investigator CEO of Envirtue Biotechnologies, Inc. He is a graduate of Hiram College (B.A., philosophy & biological science, 1993) and Syracuse University (M.Sc., biological science, 1997). Mr. Downs has spent over six years investigating the role of small heat-shock proteins in both plants and animals, and has worked closely with Dr. Cheryl Woodley to refine cellular and molecular techniques for assessing stress in a wide range of biota.

LITERATURE CITED

Downs, C.S., E. Mueller, S. Phillips, J.E. Fauth, and C. M. Woodley. 2000. A molecular biomarker system for assessing the health of coral (*Montastraea faveolata*) during heat stress. Mar. Biotechnol. 2:533-544.

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FY 02 *EXXON VALDEZ* TRU: **COUNCIL PROJECT BUDGET**

October 1, 200 ptember 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$24.4						
Travel		$8.4						
Contractual		$66.0						
Commodities		$5.0						
Equipment		$2.0						
Subtotal	$0.0	$105.8	Estimated FY 2003					
General Administration		$8.3						
Project Total	$0.0	$114.1						
Full-time Equivalents (FTE)		0.3						
			Dollar amounts are shown in thousands of dollars.					
Other Resources								

Comments:

FY02

Prepared:

Project Number: 02644
Project Title: Molecular Biomarkers as a New Technique for Assessing Physiological Contaminant Stress
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

FY 02 *EXXON VALDEZ* TRU: COUNCIL PROJECT BUDGET

October 1, 200 :ptember 30, 2002

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2002
Gary Shigenaka	Oceanographer	GS/13/5	2.0	6.0		12.0
Cheryl Woodley	Biologist	GS/14/1	2.0	6.2		12.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		4.0	12.2	0.0	
					Personnel Total	$24.4

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2002
PI planning meeting November 2001	0.5	2	2	0.1	1.2
Trustee workshop January 2002	2.0	2	6	0.1	4.6
Field sampling, PWS & LCI	1.0	1	4	0.1	1.4
PI meeting September 2002	0.5	2	2	0.1	1.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$8.4

FY02

Prepared:

Project Number:
Project Title: Molecular Biomarkers as a New Technique for Assessing Physiological Contaminant Stress
Agency: NOAA

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FY 2002
Envirtue Biotechnologies, molecular biomarker analysis	20.0
Louisiana State University, chemical analysis	16.0
Float plane charter, 4 days	10.0
Laboratory challenges	20.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$66.0

Commodities Costs:	Proposed
Description	FY 2002
Misc. sampling supplies	5.0
Commodities Total	$5.0

FY02

Prepared:

Project Number:
Project Title: Molecular Biomarkers as a New Technique for Assessing Physiological Contaminant Stress
Agency: NOAA

FORM 3B
Contractual & Commodities DETAIL

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2002
Liquid nitrogen dewars	1	2.0	2.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$2.0

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency

FY02

Prepared:

Project Number:
Project Title: Molecular Biomarkers as a New Technique for Assessing Physiological Contaminant Stress
Agency: NOAA

FORM 3B
Equipment
DETAIL

Information Dissemination through the Web: Developing an Interactive Database on South-Central Alaskan Seaweeds

Part 1. Species Images, Maps, and Traditional Use (submitted under BAA)

Project Number:	02646-BAA
Restoration Categories:	GEM Transition; Public Information; Subsistence Documentation
Proposer:	Gayle I. Hansen (Oregon State University, HMSC) and Michael S. Stekoll (University of Alaska Southeast)
Lead Trustee Agency:	
Cooperating Agencies:	
Alaska Sea Life Center:	No
Duration:	1st year, 3-year project (A usable completed product will be available at the end of each year as insurance against future funding limitations)
Cost FY 01:	$54.2
Geographic Area:	No field work will be carried out, but specimens from the entire EVOS area will be used for the study
Injured Resource/Service:	Intertidal Communities: macrobenthic marine algae or seaweeds. Subsistence

ABSTRACT

The macrobenthic marine algae or seaweeds are an integral component of Alaska's near-shore ecosystem. They are the base of the food chain for many marine animals and have long been used as a part of the diet of indigenous peoples. Surprisingly, the correct identification of most algal species is still elusive to many people. In order to begin to overcome this problem, we will produce a Web-based database of algal images and distributions that will greatly facilitate species identifications. With this as a reference, we will query the native communities for information on the traditional uses of the species and add this important data to our final product. The website will develop incrementally as species are added and comments from users are incorporated.

INTRODUCTION

Project plan:

We are now living in a new age of information dissemination. With the advent of the Internet and its commercialization in 1991, the methods by which information can be distributed have changed dramatically. Electronic mail and Internet access are available to millions of individuals and organizations worldwide and instantaneous electronic communication is possible even to very remote areas. Across Alaska, the Internet is extremely popular and widely used. We plan to use this medium to publish a visual guide to the seaweed species of the EVOS area that will be useful for identification purposes and for communicating information and ideas about Alaskan algae to all that are interested. Our Website will contain: an introduction to the macroscopic marine algae of the area, a checklist of the scientific and common names of the species, full color scanned images and distribution maps of each of the species, and a suggestion/question box for interaction with our users. During our initial year, we will include approximately 300 of the larger seaweed species. Then, during the following two years, we will add in the smaller more microscopic forms, anatomical features of the species, written descriptions, keys, and useful references. In order to facilitate use of the Website, we will prepare the taxonomic portion as a linked interactive database. We will develop and post the database incrementally so that we can obtain feedback from our users and make appropriate modifications. We will respond to suggestions and to questions on algae from all of those who use our suggestion/question box either directly on the Website or through e-mail. During this first year of our project, we will also use the Website in combination with mailed questionnaires to obtain and distribute information on the traditional uses of seaweeds.

Resources Available:

More than 300 easily observable macroscopic marine algae occur in south-central Alaska. During the CHIA studies of EVOS, approximately 7300 specimens of these algae were collected, pressed and curated as site voucher collections for the investigation. These specimens were identified, labeled, and databased so that they could be used as reference material for future investigations of the oil spill area. Currently the database from these collections is being used as the basis of our 2000-2001 Restoration Project entitled "A Checklist and Distributional Analysis of Marine Algal Species collected during the CHIA-EVOS Studies". We have discovered many interesting distribution patterns in these species and will report our overall findings in a peer-reviewed journal publication. However, due to journal space restrictions, we will be unable to publish distribution maps of the individual species or to include photographs of even the more remarkable specimens.

The CHIA-EVOS collections were meticulously made and contain hundreds of large and beautiful examples of the south-central Alaskan marine algae. Many are "textbook" specimens that are extremely valuable for teaching. However, in many ways, their value is wasted, since few people will have the opportunity to visit the collections (housed in Juneau and in Newport) and fewer still are even aware they exist. It is this important resource that we plan to use for display in our project.

NEED FOR THE PROJECT

A. Scientific Background:

Macrobenthic marine algae or seaweeds are essential components of nearly all near-shore ecosystems in Alaska. They form the base of the food chain in rocky intertidal and shallow subtidal communities, and, in areas where they flourish, they benefit both the structural and chemical environment. Near-shore marine animals are all at least partially dependent on algae for survival, and the environmental stresses that impact the algae also impact these members of the higher trophic levels. Since disturbances that affect ecosystems are often first detectable in the algae, it is imperative that we not overlook these valuable indicators of ecosystem change.

B. Statement of the Problem:

Considering the importance of the marine algae, it is surprising that so few environmental impact studies have included seaweeds. One reason appears to be that few people are trained in marine phycology (the study of algae) and the plants are frequently difficult to identify. Although numerous algal species can be recognized in the field, many must be carefully examined in the lab and often require dissecting and/or microscopic examination for species determination. Although no marine algal identification guides have focused on south-central Alaska, several books are helpful for the identification of algae in this area. These include:

(1) Abbott and Hollenberg. (1977) *Marine Algae of California*. A comprehensive, fully illustrated account of the seaweeds of that area -- but very out-dated.
(2) Gabrielson et al. (2000). *Keys to the Benthic Marine Algae and Seagrasses of British Columbia, Southeast Alaska, Washington and Oregon*. Comprehensive keys with some excellent diagrams of species structures.
(3) O'Clair and Lindstrom (2000). *North Pacific Seaweeds*. A guide to about 1/3 of the seaweeds of southeast Alaska. Richly illustrated but still with identification errors.

All of these volumes are useful for working on Alaskan seaweeds. However, since none of them adequately illustrate or describe south-central Alaskan seaweeds, the identification of algae in this area still remains extremely difficult. A taxonomic algal Website, such as the one we propose, is critically needed in this area.

C. Rational/Link to Restoration:

With the rapidly approaching start of the Gulf Ecosystem Monitoring Program, it is more important than ever that we standardize the taxonomy and nomenclature of northern Gulf of Alaska species so that species designations will be uniform and translatable across all current and future restoration and monitoring projects. Our Web-based image database of the algal species will perform this function. Moreover, our database will be modifiable. Hence, as taxonomic and nomenclatural changes occur over the next hundred years, it will be able to correct the database and keep a record of these changes. As time and money allow, we will also be able to improve and expand our coverage of the species and add useful new components to the Website. This first year we will include information on the subsistence uses of the species.

Our Website will be a valuable reference and educational tool for researchers, teachers, environmental managers and subsistence users. Since we will provide color images of the species in an attractive format, it should also be a popular Website for the general public. By

providing a counter on the site, we will be able to keep track of visitor numbers, and our suggestion/question box will enable us to interact with our users.

It is our hope that our algal database will act as a prototype for future taxonomic databases on other Northern Gulf of Alaska species.

C. Location.

Project Preparation: This will occur primarily in Juneau, AK, and in Newport, OR, at the laboratories of the principal investigators. Both are equipped with computers, software, and internet access as well as with scanners and some photographic equipment. The CHIA-EVOS voucher collection, the major resource for this project, is housed primarily in Juneau where MSS and students will do most of the scanning. A reference set of several hundred EVOS specimens is located in Newport where GIH will do additional scanning and microscope work as well as preparation of the distribution maps. For this project, we feel that we should be able to fully communicate via mail, e-mail, our test Web pages, and phone. However, at the EVOS Restoration Meeting in Anchorage, we will have the opportunity to exchange specimens and work through any critical project difficulties. Here, GIH will also take the opportunity to research any published information on the traditional uses of seaweeds at ARLIS and the CRRC.

Benefited Communities: Since our project will be Web posted, individuals world-wide could benefit from our efforts. However, it is our hope that researchers, teachers, and the interested public in south central Alaska will utilize our Web database as an essential tool for algal identification and as a valuable resource for information on the uses of seaweeds.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

Seaweeds are well known to be rich sources of vitamins, minerals, and amino acids, and many native communities around the world have used these valuable plants as an important component of their diets. We would like to include information on the Alaskan traditional uses of seaweeds in our database. Since visits to the Chugach native communities for interviews would be prohibitively expensive, we plan to obtain information on seaweed uses by providing questionnaires to the communities. These will be used in combination with the pictures on our Website to determine the precise species of importance. The answers to our questionnaire will be tallied and included in our database and final report. In addition, we will work with the Subsistence Division of the Alaska Department of Fish and Game to also include information derived from earlier subsistence studies.

Sarah Ward generously provided us with a list of the phone numbers and e-mail address of the community facilitators. I have been able to reach many of the facilitators by phone and have alerted them to our proposal. Most everyone was interested in our Website and all were willing to take part in our survey.

PROJECT DESIGN

A -- Objectives.

Through our proposed Web publication, we will provide easy access to pictures and distribution maps of the marine algal species found in the oil spill area and greatly aid in their identification for both research and personal use. The "working" database will provide an avenue for distributing information on Alaskan seaweeds to researchers, teachers, native communities and to the public. For Part 1 of the project, we will post information on the traditional uses of seaweeds provided to us by the native communities and ADF&G and derived through library research.

B -- Methods.

The project will involve the following stages of preparation:

(1) Designing the Web "front end" of the database, including query and page formatting.
(2) Establishing 3 Web addresses for the project (one for trial pages, one for display, and one for backup).
(3) Preparing and posting the introduction, acknowledgements, and checklist.
(4) Scanning the specimens and/or photographs of the species
(5) Preparing Dot Distribution Maps for each species utilizing the CHIA voucher database..
(6) Posting the images and maps of the species as they are obtained and linking them to the checklist.
(7) Incorporating the visitor counter
(8) Setting up the Suggestion/Question Box.
(9) Querying the native communities for information on the traditional uses of seaweeds, conferring with ADF&G about this, and posting the results we obtain for each species in the database
(10) Preparing the final report and a short publication announcing the database.

C -- Cooperating Agencies, Contracts, and Other Agency Assistance. ADF&G, ARLIS, & CRCC have already been helpful. .MSS will be a subcontractor under OSU (see the attached subcontract proposal)

SCHEDULE

A-- Time Table for FY 01 (October 1,2001 - September 30, 2002)

<u>October - December 2001</u>

(1) GIH and MSS: Design the Web presentation: (a) Prepare the introduction and acknowledgements, and (b) Determine the queries and species page formats
(2) MSS. Establish 3 Web sites for the developing database: a test site for drafts, a publicly viewable site, and a back-up site. Incorporate the Visitor Counter and Suggestion/Question box. Begin scanning and/or photographing high quality algal specimens and their labels.
(3) GIH: Determine "Thumb-nail" storage method for extra scanned images and label data; begin scanning specimens and posting images. Send microscope out for repair.
(4) GIH. Work with GIS consultant to design Web ready dot maps of the algal distributions.

(5) GIH & MSS. Prepare abstract and poster on "Algal Distributions in South Central Alaska" for the Annual Restoration Meeting

January - June 2002

(1) GIH & MSS. Attend the Annual Restoration Meeting.
(2) GIH. Research traditional uses in Anchorage and prepare and mail out the questionnaire to native communities.
(3) MSS. Complete photographing, scanning, and posting specimen images.
(4) GIH. Scan and post images of larger specimens and prepare photomicrographs of diagnostic features of smaller species. MSS scan and incorporate these slides into the database.
(5) GIH & MSS. Review and answer questions and answers from the users. Finalize the design of the Website.

July - September 2002

(1) GIH. Tally the questionnaire on native uses of algae and incorporate it into the database.
(2) GIH and MSS. Complete the database and prepare and submit the Annual Report.

B-- Project Milestones and Endpoints

(1) December 2001: Post the preliminary database with introductory page, species lists and initial images. (Images will be incorporated continually after this). Begin monitoring and responding to our Suggestion/Question box.
(2) Jan 2002: Attend the Annual Restoration Workshop and present a poster on our earlier biogeographic study. Distribute the Questionnaire on the Traditional Uses of Seaweeds.
(3) June 2002: Complete entry and modification of all data except for traditional uses.
(4) Sept 2002: Incorporate and post the results of the query on Traditional Uses of Seaweed; Prepare and submit our Annual Report.

C. Completion Date: September 30, 2002

PUBLICATIONS AND REPORTS

(1) South-Central Alaskan Seaweeds: Images and Biogeographic Maps. [The database posted for Web dissemination on the University of Alaska Southeast's server.]
(2) A Web-based database on south-central Alaskan seaweeds, including images and distribution maps of the species. [An announcement in the Journal of Phycology]
(3) The traditional uses of seaweeds in south-central Alaska [A journal article if enough information is obtained]
(4) Information dissemination through the Web: Developing an interactive database on south-central Alaskan seaweeds. Part 1. Species Images, Maps, and Traditional Use. [Our final report]

COORDINATION AND INTEGRATION OF RESTORATION EFFORT.

This project will rely heavily on earlier EVOS funded projects. The images and biogeographic maps of the species will be derived entirely from the marine algal voucher collection and

database compiled during the CHIA study of EVOS. The notebook computer and mapping program that will be utilized for this project were purchased during the PI's 2000-2001 restoration project..

Although GIH and MSS will handle all of the data input for Part 1 of our Website, it is our hope that some of our colleagues will join us on new parts and/or future extensions of the database. These include the following people: Larry Deysher, Brenda Konar, Mandy Lindeberg, Sandra Lindstrom, Kathy Miller, Jane Middleton, and Paul Gabrielson. All have contributed greatly to our knowledge of the Alaskan marine flora.

We hope that our interactive and modifiable Web database will act as a prototype for other taxonomic databases on marine organisms in the Northern Gulf of Alaska.

PROPOSED PRINCIPAL INVESTIGATORS:

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PRINCIPAL INVESTIGATOR QUALIFICATIONS

Dr. Gayle I. Hansen is a Marine Algal Taxonomist specializing in the Alaskan and Oregon floras. She is probably best known for her part in the British Columbia Marine Algal Flora series and for her *Checklist and Biogeographic Analysis of the Marine Algae of Oregon*. As algal taxonomist for the CHIA project, she trained the algal technicians in algal identification and sampling methods and together they collected and pressed the 7,300 sheet algal voucher collection now held in Juneau. Her identifications, labels and database of this collection formed the basis for her 2000-2001 Restoration Project with M. S. Stekoll entitled: "A Checklist and Distributional Analysis of Marine Algal Species collected as Vouchers during the CHIA-EVOS Studies". Currently, she is also working with S. C. Lindstrom on a database of the label information from all known specimens of marine algae taken from Alaska.

Dr. Michael Stekoll is a Professor of Chemistry and Biochemistry at the University of Alaska Southeast, and the School of Fisheries and Ocean Sciences at the University of Alaska Fairbanks. He has served as the Principal Investigator for the coastal habitat injury assessment (CHIA) study and Herring Bay experimental and monitoring studies that examined the impacts of the EVOS on intertidal and subtidal algae. His specialties include studies of *Fucus, Macrocystis*, and other seaweeds in Alaska and the effects of pollution on aquatic organisms.

OTHER DATABASE CONTRIBUTORS

Numerous other people will be acknowledged for their part in our working database. These will include: the algal specimen collectors and identifiers, individuals who take part in scanning and photographing the specimens, those who provide suggestions through our Website, and all of those who answer our questionnaire on the uses of algae.

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Silva, P. C. & R. L. Moe. Index Nominum Algarum, Bibliographica Phycologica Universalis. University Herbarium, University of California, Berkeley. http://128.32.109.44/e-ina.html

Wood, S. & S. Etchemendy. Marine Algae *in* Marine Taxonomic Databases, PISCO.
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SUBCONTRACT

University of Alaska Project Proposal

Project Title:	Information Dissemination through the Web: Developing an Interactive Database on South-Central Alaskan Seaweeds. Part 1. Species Images, Maps, and Traditional Use (submitted under BAA)
Submitted to:	Oregon State University Hatfield Marine Science Center Oregon State University 2030 Marine Science Drive Newport, Oregon 97365
From:	Faculty of Math and Science University of Alaska Southeast 11120 Glacier Highway Juneau, AK 99801
Principal Investigator:	Michael S. Stekoll Professor SS# 559742413
New/Continuation:	New
Duration:	October 1, 2001 to September 30, 2002
Proposed Start Date:	October 1, 2001

Project Budget:

	OSU (from EVOS)	UAS Match	Total
First Year	$15,291	$13,000	$28,291

Michael S. Stekoll
Principal Investigator

Mary Lou Madden
Dean of Faculty

Carol Griffin
Chief Financial Officer

4-10-01
Date

Information Dissemination through the Web
Developing an Interactive Database on South-Central Alaskan Seaweeds.
Part 1. Species Images, Maps, and Traditional Use (submitted under BAA)

A sub-contract submitted to Oregon State University.

NEED FOR THE PROJECT

During the CHIA studies by the University of Alaska, support was provided for the field studies, but, due to its litigation sensitivity, no support was given for publishing the data. This left a huge amount of information unavailable to the scientific community and to the public. This proposal is for financial support to place images and information on the internet about benthic seaweeds from the region affected by the oil spill. This information will be a valuable aid in any research to be performed in the intertidal areas in this region. One reason is that few people are trained in recognition of the seaweeds, and the plants are often difficult to identify. Although many algal species can be recognized in the field, many must be carefully examined in the lab, and some require dissecting and/or microscopic examination for species determination. There are currently no marine algal identification guides that have focused on south-central Alaska. This project will be the first to publish usable information on the benthic seaweeds from this region..

PROJECT DESIGN

A -- Objectives.

The proposed Web publication will provide an easy access to pictures and distribution maps of the marine algal species found in the oil spill area and will aid in their identification for both research and personal use. The "working" database will provide an avenue for distributing information on Alaskan seaweeds to researchers, native communities and to the public. For Part 1 of our project, we will post information on the traditional uses of seaweeds provided to us by the native communities.

B -- Methods.

The project will involve the following stages of preparation:

(1) Designing the Web "front end" of the database, including query and page formatting.
(2) Establishing a Web address for the project through the University of Alaska.
(3) Preparing and posting the introduction, acknowledgements, and searchable checklist.
(4) Scanning the specimens and/or photographs of the species
(5) Preparing distribution maps for each species utilizing the CHIA voucher database..
(6) Posting the images and maps of the species as they are obtained.
(7) Preparing the final report and journal publications announcing the database

SCHEDULE

A-- Time Table for FY 01 (October 1,2001 - September 30, 2002)

<u>October - December 2001</u>

- MSS to help design the Web presentation: (a) Prepare the introduction and acknowledgements, and (2) Determine the queries and species page formats
- MSS will establish both a test (for drafts) and a final site for the developing Web database. Work to begin scanning and/or photographing high quality algal specimens and their labels.
- MSS will help prepare abstract and poster on "Algal Distributions in South Central Alaska" for the Annual Restoration Meeting

January - June 2002

- Attend the Annual Restoration Meeting.
- MSS will complete photographing, scanning, and posting images of specimens
- MSS will scan and incorporate these slides from GIH into the database.
- MSS help review comments from users and finalize design of the Web database.

July - September 2002

- Complete the database and prepare and submit the Final Report.

B-- Project Milestones and Endpoints

- December 2001: Post the preliminary database with introductory page, species lists and initial images. (Images will be incorporated continually after this)
- Jan 2002: Attend the Annual Restoration Workshop and present a poster on our earlier biogeographic study.
- June 2002. Complete entry and modification of all data except for traditional uses.
- Sept 2002. Prepare and Submit our Annual Report.

Completion Date: September 30, 2002

PUBLICATIONS AND REPORTS

(1) Hansen, G. I., and M. S. Stekoll. Announcing an Interactive Database on South-Central Alaskan Seaweeds Providing: (1) Images and Distribution Maps of the Species, and (2) The Results of an Inventory on the Traditional Use of the Species (This will be published as a short announcement in the Journal of Phycology. If enough information is available, the traditional use component will be published as a separately).

(2) Hansen, G. I., and M. S. Stekoll. South-Central Alaskan Seaweeds: Images and Biogeographic Maps. A Database Posted for Universal Use on the University of Alaska Southeast's Server.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT.

This project will rely heavily on earlier EVOS funded projects. This images and biogeographic maps of the species will be derived entirely from the marine algal voucher collection and database compiled during the CHIA study of EVOS. The notebook computer and mapping program that will be utilized were purchased during the Pi's 2000-2001 restoration project..

We hope that our Web-based interactive and modifiable database will act as a prototype for other taxonomic databases on marine organisms in the Northern Gulf of Alaska.

PRINCIPAL INVESTIGATOR

The Principle Investigator on this project will work cooperatively with Dr. Gayle Hansen at the Hatfield Marine Science Center, Oregon State University.

Michael S. Stekoll, Ph. D. (Professor of Biology, UAS and SFOS/UAF
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Juneau, Alaska 99801
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PRINCIPAL INVESTIGATOR QUALIFICATIONS

Dr. Michael Stekoll is a Professor of Biology at the University of Alaska Southeast, and the School of Fisheries and Ocean Sciences at the University of Alaska Fairbanks. He has served as the Principal Investigator for the coastal habitat injury assessment (CHIA) study and Herring Bay experimental and monitoring studies that examined the impacts of the EVOS on intertidal and subtidal algae. His specialties include studies of *Fucus, Macrocystis*, and other seaweeds in Alaska.

BUDGET:

Stekoll:

Salaries and Leave (1 month)	$7,631
Benefits	2,045
Travel	650
Supplies	1,000
Overhead @35%	3,964
Total	$15,291

FY 02 *EXXON VALDEZ* TRU! COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002	LONG RANGE FUNDING REQUIREMENTS					
Personnel G. I. Hansen		$17.5						
Travel		$1.1						
Contractual		$16.9						
Commodities		$1.7						
Equipment		$0.7						
Subtotal	$0.0	$37.9	Estimated FY 2003	Estimated FY 2004				
OSU Indirect Cost 43%		$16.3						
Project Total	$0.0	$54.2	$35.0	$25.0				
Full-time Equivalents (FTE)		0.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

GIH's salary includes: $11,762.5 salary for 2.5 months ($4705/month) spread out over 5 months with 49% fringe or $5,763.63.

Mike Stekoll's FTE is included under contractual. Between the two of us, we will have 0.3 FTE.

FY02

Prepared: 12 April 2001

Project Number: 02646-BAA
Project Title: Information Dissemination through the WEB: Developing an Interactive Database on South-Central Alaskan Seaweeds. Part 1. Species Images, Maps, and Traditional Use
Name: Gayle I. Hansen and Michael S. Stekoll

FORM 4A
Non-Trustee
SUMMARY

FY 02 *EXXON VALDEZ* TRU : COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 2002
Gayle I. Hansen	Principal Investigator (with 49% fringe) (20% = Traditional Uses of Algae)		2.5	7.0		17.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		2.5	7.0	0.0	
					Personnel Total	$17.5

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2002
Annual Restoration Workshop-2002	0.6	1	3	0.1	0.9
Research at ARLIS and CRCC on Traditional Uses of Algae			2	0.1	0.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.1

FY02

Prepared: 12 April 2001

Project Number:
Project Title: Information Exchange through the Web: Developing an Interactive Database on South-Central Alaskan Seaweeds. Part 1. Species Images, Maps, and Traditional Use Queries. Name: Gayle I. Hansen and Michael S. Stekoll

FORM 4B
Personnel
& Travel
DETAIL

FY 02 *EXXON VALDEZ* TRU : COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Contractual Costs:						Proposed FY 2002
Description						
Web and GIS Consultant at HMSC, Newport, OR						1.6
Michael S. Stekoll at University of Alaska Southeast, Juneau, AK (also see attached subcontract)						
	Salary (with fringe)	1 month		9.6		
	Travel to Annual Restoration Workshop			0.7		
	Zip Diskettes, film and developing, phone calls, mailing costs			0.5		
	Copy stand			0.5		
				11.3	Subtotal	
	UAS	Overhead	35%	4.0		
				15.3		15.3
					Contractual Total	$16.9

Commodities Costs:	Proposed FY 2002
Description	
Equipment Repairs (my Zeiss icroscope and attached camera need repair, alignment, and cleaning)	1.0
Internet Connection, phone calls, zip disks, film and developing for microscopic shots	0.4
Phone Calls, Internet Connection, and Questionnaire Mailings -- for the Traditional Uses of Seaweeds	0.3
Commodities Total	$1.7

FY02

Prepared: 12 April 2001

Project Number:
Project Title: Information Dissemination through the WEB: Developing an Interactive Database on South-Central Alaskan Seaweeds. Part 1. Species Images, Maps, and Traditional Use
Name: Gayle I. Hansen and Michael S. Stekoll

FORM 4B
Contractual & Commodities DETAIL

FY 02 *EXXON VALDEZ* TRU : COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2002
Digital Camera (Kodak)	1		0.7
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.	**New Equipment Total**		$0.7

Existing Equipment Usage:	Number
Description	of Units
Zeiss Axioskope compound photomicroscope	1
Zeiss SR dissecting microscope	1
Notebook computer with WEB access and 256 ram for database use and a 20 GB hard drive	1
Desktop computer with WEB Access and a 20 GB hard drive and 128 mb of RAM	1
Microtek Scanner with a 12x17" scanning bed	1
Copy Stand	1
Software: MS Windows 2000, MS Office Professional 2000, Adobe Photoshope, Adobe Go-Live	1
My Fairly Extensive Algal Library and Alaskan Herbarium	1

FY02

Prepared: 12 April 2001

Project Number:
Project Title: Information Dissemination through the Web: Developing an Interactive Database on South-Central Alaskan Seaweeds. Part 1. Species Images, Maps, and Traditional Use
Name: Gayle I. Hansen and Michael S. Stekoll

FORM 4B
Equipment
DETAIL

Budget Justification:

The PI's salary is set by our universities. GIH and MSS will utilize only .3 FTE, but they will spread their respective salaries out throughout the year. GIH will work half time for 5 months on the project. MSS will work sporadically through the year.

GIH has requested $1.6 (thousand) for consultant support for expertise on the Web posting of databases and maps.

We are each equipped with most everything we will need for the project. However, GIH will need a digital camera for taking habit shots of unusually large or small species. MSS requires a copy stand for similar purposes. Otherwise we will primarily scan our images into the computer.

Our Commodities costs include Internet, long distance phone calls, and postage.

COST EFFECTIVE DATA ACQUISITION USING ADAPTIVE SAMPLING AND COMBINING INFORMATION STRATEGIES
(SUBMITTED UNDER THE BAA 52ABNF100031)

Project Number:	02648 - BAA
Restoration Category:	Ecosystem Synthesis/GEM Transition, Innovative Tools and Strategies to Improve Monitoring
Proposed by:	Dr. Dovalee Dorsett Baylor University Waco, TX 76708
Lead Trustee Agency:	
Cooperating Agencies:	Alaska Fisheries Science Center NOAA 7600 Sand Point Way NE Seattle, WA 98115
Alaska SeaLife Center:	No
Duration:	FY02 (October 1,2001 to September 30, 2002) - 1st year, 2-year project
Cost FY02:	$52,500
Cost FY03:	$54,300
Geographic Area:	Alaska Fisheries Science Center, NOAA, Seattle, WA
Injured Resource/Service:	The methodology will be applicable to all data collection efforts.

ABSTRACT

The analysis of data acquired in a pilot study of adaptive sampling by FOCI in 1999 will provide information for designing adaptive sampling methods to be used in GEM. Detailed adaptive sampling methods will be documented to enhance cost effective methods of data collection. In a second phase, statistical methods of combining data from different sources will be determined and documented for further efficient data utilization.

INTRODUCTION

The purpose of this project is to develop statistically optimal sampling strategies to improve monitoring as efforts move into the GEM (Gulf Ecosystem Monitoring) phase. In addition to designing such plans, additional efficiency of data utilization will incorporate statistical methods of combining information.

NEED FOR THE PROJECT

A. Statement of Problem

Sampling populations of marine life over large bodies of water is especially expensive, often involving ships and scientific personnel at sea for weeks at a time during each survey operation. In addition, many of these marine populations occur in clusters (i.e. schools of fish, pods of whales, etc.). This can be especially true of early stages of life, such as the larval stage of fish (Hilborn and Walters, 1992). Traditional statistical sampling designs of experiments at sea involve a random or systematic sampling approach that is not the most efficient method of collecting data that occurs in clusters. A more efficient method is that of adaptive sampling which seeks to first locate clusters and then sample in a grid around the cluster (Thompson and Seber, 1996).

Also of interest to GEM will be other methods of non-traditional sampling such as placement of oceanographic instrumentation packages on ships of opportunity. Appropriate statistical methods of combining information need to be determined and documented.

B. Rational/Link to Restoration

The methods that will be developed and documented during this project will be widely applicable to many phases of GEM as they are methods especially designed to provide cost effective methods of obtaining samples and utilizing the data from different sources.

C. Location

In 1999, Dovalee Dorset, the author of this proposal, joined a team of NOAA scientists from the Fisheries and Oceanography Coordinated Investigations program of the Alaska Fisheries Science Center to study larval walleye pollock, *Theragra chalcogramma*, in Shelikof Strait. The survey design was a pilot study of a modified adaptive sampling plan. The resulting data set has been processed and is ready for analysis. The analysis and subsequent documentation of appropriate adaptive sampling plans for GEM utilization will be conducted jointly by research scientists at the Alaska Fisheries Science Center in Seattle and Dovalee Dorsett at Baylor University in Waco, Texas.

PROJECT DESIGN

A. Objectives

In FY02, the objectives are:

1. Analyze existing data from a pilot study of a modified adaptive sampling plan to compare precision and power of such methods with more traditional methods.

2. Establish documented protocols for implementation of adaptive sampling plans in the GEM phase.

In FY03, the objectives are:

1. Examine various non-traditional methods of data acquisition and establish documented protocols for the statistical combining of information from various sources.

B. Methods

Adaptive sampling is a sampling design in which the procedure for selecting sample site and allocating sampling effort depends on data collected during the survey. The theoretical details of adaptive sampling are found in a book by Thompson and Seber entitled *Adaptive Sampling*. In practical applications, some modifications are often necessary. Ships cannot economically sample in a random manner, but a systematic sampling design can be incorporated into the adaptive sampling design.
In May 1999, the Alaska Fisheries Science Center used a modified adaptive sampling to sample walleye pollock larvae in the Shelikof Sea Valley between the Alaskan Peninsula and Kodiak Island. The data set has been processed and is ready for analysis. Part of this project would involve the analysis of this data set to determine the applicability and efficiency of the adaptive sampling methods. The general analysis of these data includes estimation of abundances and distributions of larval walleye pollock and patch studies where characteristics of fish in each patch (cluster) are examined.

Available for comparison are data from previous surveys as well as simulations of adaptive sampling methods applied to the sampling of the walleye pollock (Bailey and Macklin, 1994, Kendall and Picquelle, 1990, Mier and Picquelle, in prep.). From these sources we will examine the precision (errors of estimation) and power of the adaptive sampling methods.

In addition to designed experiments for collection of data using adaptive sampling, other sources of data can provide cost effective strategies. Instruments placed on fishing vessels, cruise ships, and other platforms of opportunity can provide data like bathymetry, sea surface temperature, and salinity. The Alaska Fisheries Science Center has access to "observer data", that is data collected by observers, hired by NMFS, who go out on commercial cruises and collect data on commercial catches. A second phase of this project, anticipated for FY03, is to determine protocols and document statistically sound methods of combining data from various sources (Dorsett and Odell, 1989, 1993; Odell and Dorsett, 1989, 1990).
The implementation of adaptive sampling designs and statistically sound combining information from non-traditional data can provide cost effective and efficient data collection strategies.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

This project will be conducted in cooperation with research scientist at the Alaska Fisheries Science Center in Seattle, WA. Cooperating scientist from the Alaska Fisheries Science Center will include Kevin M. Bailey, Susan J. Picquelle, and Kathryn L. Mier.

SCHEDULE

A. Measurable Project Tasks for FY02 (October 1, 2001-September 30, 2002)

Dovalee Dorsett, the project authorr, will work ¼ time during the academic year on this project and full time for two months in the summer of 2002 on this project. It is anticipated that when necessary during the academic year, the fall break, between semester break, and spring break times will be spent in Seattle working with the research scientist. Then, two months in the summer will be spent full time on this project.

FY02

October 18-22 (Baylor Fall Break):	Dovalee Dorsett will meet with scientists at the Seattle Alaska Fisheries Science Center to obtain data and begin analysis.
December 10-January 15:	Complete initial analysis of data.
January 14-23 (2 days)	Attend the *Exon Valdez* Oil Spill Trustee Council's Annual Restoration Workshop in Anchorage, Alaska.
March 4-8:	Dovalee Dorsett will meet and work with scientist at Seattle Alaska Fisheries Science Center to review analysis results and begin work on adaptive sampling protocols.
May 15 – July 15:	Work on adaptive sampling procedures and document protocols. Begin writing papers for presentation and publication.
September 15:	Submit manuscript to peer reviewed journal and submit quarterly report.
April 15, 2003:	Submit annual report for FY02.

B. Project Milestones and Endpoints

For FY02 milestones and endpoints are:

December 31:	Complete initial analysis of data and submit quarterly report.
March 31:	Dovalee Dorsett will have met with Alaska Fisheries Scientist and begun adaptive sampling evaluation. Provide quarterly report.
June 30:	Draft of adaptive sampling protocols will be completed and quarterly report submitted.

August 10-15:	Attend annual meeting of the American Statistical Association and present paper.
September 15:	Complete manuscript and submit to peer review journal.
September 31:	Submit quarterly report.
April 15, 2003:	Submit Annual Report for FY02.

For FY03 milestones and endpoints are:

December 31:	Complete initial assessment of information sources for data acquisition. Submit quarterly report.
March 31:	Submit quarterly report.
June 30:	Complete draft of protocols for statistical combining of data. Submit quarterly report.
August 3-7:	Attend annual meeting of the American Statistical Association and present paper.
Sept. 15:	Submit manuscript for peer review journal.
September 31:	Complete protocols for statistical combining of information and submit quarterly report.
April 15, 2004:	Submit final report.

C. Completion Date

Both phases of the project will be met by the end of FY03. The final report will be submitted by April 14, 2004. The adaptive sampling design strategies will be completed by the end of FY02 and the combining information strategies will be completed by the end of FY03.

PUBLICATION AND REPORTS

In September, 2002, a paper entitled "Adaptive Sampling Applications in the Gulf of Alaska" will be submitted to one of the following: *Marine Ecology Progress Series, Environmental and Ecological Statistics, or The Canadian Journal of Fisheries and Aquatic Sciences.*
A paper entitled "Combining Various and Non-standard Sources of Marine Data in a Statistically Sound Method" will be submitted to one of these same journals in September of 2003.

PROFESSIONAL CONFERENCES

It is anticipated that at least two papers will be presented professional meetings. One paper presented by Dovalee Dorsett will be entitled "Statistical Methods in Environmental Science" at the Annual Meeting of the American Statistical Society in August, 2002.
Another paper will be presented jointly with scientists from the Alaska Fisheries Science Center at either ICES (International Council for the Exploration of the Sea) or PICES (North Pacific Marine Science Organization in FY02.

PROPOSED PRINCIPAL INVESTIGATOR

Dr. Dovalee Dorsett
Department of Information Systems
Baylor University
P.O. Box 98005
Waco, TX 76708

Phone: 254-710-6200
Fax: 254-710-1091
Email: dovalee_dorsett@baylor.edu

PRINCIPAL INVESTIGATOR

Dovalee Dorsett is a professor of statistics in the Department of Information Systems at Baylor University. She has a Ph.D. in Statistics from Southern Methodist University. She has worked for the past several years with the statisticians at the Alaska Fisheries Science Center on the development of adaptive sampling plans. She joined the research scientist in 1999 in a pilot study of adaptive sampling in the Shelikof Strait (Dorsett, 2000). Dr. Dorsett has also conducted research and published in the area of combining information (Dorsett and Odell, 1989, 1990, Odell and Dorsett, 1989, 1990).

OTHER KEY PERSONNEL

Key personnel from the Alaska Fisheries Science Center are:
Kevin M. Bailey
Susan J. Picquelle
Kathryn L. Mier

LITERATURE

Bailey, Kevin M. and Macklin, S. Allen, "Analysis of patterns in larval walleye Pollock *theragra chalcogramma* survival and wind mixing events in Shelikof Strait, Gulf of Alaska", *Mar. Ecol. Prog. Ser.*, Vol. 113:1-12, 1994.

Dorsett, Dovalee and Odell, Patrick L., "An illustrative example of shrinkage estimator models", *The Texas Journal of Science*, Vol. 41, No. 3, 1989.

Dorsett, Dovalee and Patrick L. Odell, "A model for estimating environmental risk using multidimensional quantal response surfaces", *Math. Comput. Modelling,* Vol. 17., No. 1:77-94, 1993.

Dorsett, Dovalee, "An Application Of Adaptive Sampling", Presented in the Mathematics Section at the Texas Academy of Science Annual Meeting, March, 2000.

Hilborn, Ray and Walters, Carl J., *Quantitative Fisheries Stock Assessment: Choice, Dynamics &*

Uncertainty, Chapman & Hall, 1992.

Kendall, Arthur W., Jr. and Picquelle, Susan J., "Egg and Larval Distributions of Walleye Pollock *theragra chalcogralmma* in Shelikof Strait, Gulf of Alaska", *Fishery Bulletin, U.S.* 88:133-154, 1990.

Mier, Kathryn L. and Picquelle, Susan J., "Using simulation to compare survey designs for estimating abundance of spatially aggregated populations", in prep.

Odell, P. L., Dorsett, D., Young, D., and Igwe, I., "Estimator models for combining vector estimators", *Mathl. Comput. Modelling*, Vol.12, No. 12:1627-1642, 1989.

Odell, Patrick L. and Dorsett, Dovalee, "Models for combining vector estimators of random parameters", *Mathl. Comput. Modelling*, Vol. 13, No. 8:57-68, 1990.

Thompson, Steven K. and Seber, George A., *Adaptive Sampling*, John Wiley & Sons, Inc., 1996.

Budget Category:	Authorized FY 2001	Proposed FY 2002	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$39.6						
Travel		$6.1						
Contractual		$0.0						
Commodities		$0.0						
Equipment		$0.0						
Subtotal	$0.0	$45.7	Estimated					
Indirect		$6.8	FY 2003					
Project Total	$0.0	$52.5	$54.3					
Full-time Equivalents (FTE)		0.4						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

Personnel: Dr. Dorsett, PI, 25% time and effort during the academic year and 100% during two summer months in an amount equal to $31.8 thousand. Fringe benefits, which include health, disability, and life insurance, retirement, and FICA, equal $7.8 thousand.

Travel: three trips to Seattle, WA are requested in the amount of $4.2 thousand. One trip to Anchorage, AK, is requested in the amount of $1.9 thousand.

Indirect Cost: requested at 15% of total direct cost, or $6.8 thousand (.15 x $45.7 = $6.8).

Estimate for FY 2003: a 3.5% increase is requested for activity in Year 2 in the amount of $54.3 thousand.

FY02

Prepared: 4/5/01

Project Number: 02648-BAA
Project Title: Cost Effective Data Acquistion Using Adaptive Sampling and Combining Information Strategies
Name: Dovalee Dorsett

FORM 4A
Non-Trustee
SUMMARY

onnel Costs: COUNCIL PROJECT BUDGET

Name	Position Description October 1, 2001 - September 30, 2002	Months Budgeted	Monthly Costs	Overtime	Proposed FY 2002
D. Dorsett	Professor, Baylor U., and P.I.	4.5	8.8		39.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
	Subtotal	4.5	8.8	0.0	
				Personnel Total	$39.6

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 2002
Two round trips to Seattle, WA by Dovalee Dorsett	1.0	3	6	0.2	4.2
					0.0
					0.0
One round trip to Anchorage, Alaska by Dovalee Dorsett (to attend Annual Restoration Workshop)	1.5	1	2	0.2	1.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$6.1

FY02

Prepared:

Project Number:
Project Title: Cost Effective Data Acquistion Using Adaptive Sampling and Combining Information Strategies
Name: Dovalee Dorsett

FORM 4B
Personnel & Travel DETAIL

Contractual Costs:	Proposed
Description (October 1, 2001 - September 30, 2002)	FY 2002
Contractual Total	$0.0

Commodities Costs:	Proposed
Description	FY 2002
Commodities Total	$0.0

FY02

Prepared: 4/5/01

Project Number:
Project Title: Cost Effective Data Acquistion Using Adaptive Sampling and Combining Information Strategies
Name: Dovalee Dorsett

FORM 4B
Contractual & Commodities DETAIL

Equipment Purchases: FY 02 E	ET Number	Unit	Pl ed
ription October 1, 200 . September 30, 2002	of Units	Price	FY 2002
(No new equipment will be required.)			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number
Description	of Units
Desktop Computer at Baylor University	1
Dell Laptop Computer, Baylor University	1
S+ and SAS statistical Software	1
Desktop Computer at Alaska Fisheries Science Center, Seattle.	1

FY02

Prepared: 4/5/01

Project Number:
Project Title: Cost Effective Data Acquistion Using Adaptive Sampling and Combining Information Strategies
Name: Dovalee Dorsett

FORM 4B
Equipment
DETAIL

Reconstructing Sockeye Populations in the Gulf of Alaska over the Last Several Thousand Years: The Natural Background to Future Changes

Project Number:	02649
Restoration Category:	Research and monitoring
Proposers:	Daniel Mann and Bruce Finney, University of Alaska
Lead Trustee Agency:	
Cooperating Agencies:	
Alaska Sea Life Center:	No
Duration:	First year, one-year project
Cost FY 02:	$102,912
Cost FY 03:	None
Geographic areas:	Eshamy and Solf Lakes (Prince William Sound), Upper Russian Lake (Kenai River watershed)
Injured Resource/Service:	Sockeye salmon

ABSTRACT

We want to reconstruct the last 2000 years of changes in sockeye salmon abundance in Eshamy Lake (Prince William Sound) and Upper Russian Lake (Kenai River watershed) by analyzing ^{15}N in lake sediments. This new data will be synthesized with ongoing studies at Karluk Lake (Kodiak Island). Our research question is: *What is the normal variability in sockeye salmon populations in the Gulf of Alaska?* This research contributes to development of the GEM program by providing a valuable historical perspective on present conditions and by developing new hypotheses about the climatic causes of population fluctuations in Gulf of Alaska salmon.

INTRODUCTION

A. Laying a foundation for GEM

A priority for proposals solicited by EVOS for FY 02 is to establish a foundation for the GEM program. The primary mission of the Gulf Environmental Monitoring Program is to understand how natural and human-caused changes affect marine ecosystems in the northern Gulf of Alaska (GOA). We can learn a lot about present ecosystems by documenting their past responses to global changes and human activities. Information on ecosystem history can help us predict future changes. Here we propose a retrospective study of sockeye abundance in Prince William Sound and in the Kenai River watershed using the stable isotope tracers present in the sediments of spawning lakes. Our goal is to describe changes in sockeye salmon abundance over the last several millennia and to relate these changes to shifts in the climate/ocean system of the GOA and to human activities.

B. Sockeye salmon

Sockeye are an important for Native subsistence and for commercial and recreational fishing. The Trustee Council has previously made large investments in sockeye salmon recovery by purchases of stream bank, lakeside, and watershed habitats and by funding studies that detail the effects of over escapement caused by the spill. The over escapement impact was caused by the return of larger than normal numbers of spawning fish because of fisheries closures resulting from concern over oil contamination. Increased juvenile sockeye populations caused overgrazing of zooplankton stocks in spawning lakes, with consequent effects throughout the food chain. Growth rates were reduced during the freshwater part of the sockeyes' life history, and declines occurred in the health of adult fish. We have little idea about the relative severity of these over escapement effects relative to natural, prehistoric variations in sockeye populations.

C. The importance of retrospective studies

Retrospective studies like the one we propose here directly address the GEM program's goals of detecting and understanding of changes in the GOA ecosystem. To detect trends of change, we need historical data. To disentangle human-caused from nature-caused changes, we need historical data that extend back before the arrival of Europeans in the region (e.g., Finney et al., 2000). To understand the marine ecosystem, we need to describe the natural changes upon which human influences are superimposed. By understanding what happened in the past, we gain valuable perspectives on the present. In this time of global changes, learning how species and ecosystems responded to previous shifts in the environment can inform us about their future responses.

D. Previous retrospective studies of salmon populations

Finney et al. (2000) describe a 300-year record of sockeye population changes in seven lakes on Kodiak Island and the Alaska Peninsula using measurements of marine-derived nitrogen preserved in the bottom sediments of spawning lakes (Fig. 1). Marked changes in population size were found both before and after the start of intensive fisheries around AD 1900. The prehistoric changes are related to climate change (see next section), and the post-1900 changes to a combination of both climate change and fishery activity. The ^{15}N method provides a powerful tool for reconstructing changes in salmon populations in the GOA region.

BACKGROUND

A. Recent changes in the GOA atmosphere/ocean system

The northern Gulf of Alaska has seen dramatic environmental changes over the last several millennia, many of which resulted from shifts in the position and intensity of the Aleutian Low (Cayan and Peterson, 1989; Lackmann and Gyakum, 1996; Mock et al., 1998). The intensity of the Aleutian Low varies at all time scales, though only those within the span of the instrumental record (ca. 100 years) are known with any certainty (Francis et al., 1997). The best studied of these variations is the Pacific Interdecadal Oscillation (PDO), which is the coupled variation in sea surface temperature (SST) and sea level pressure (SLP) resulting from the alternation between two, self-reinforcing, and quasi-stable circulation regimes in the North Pacific climate system (Latif and Barnett, 1996; Minobe, 1997; Overland et al., 1999). The PDO has undergone two complete oscillations since AD 1900 (Mantua et al., 1997). During positive phases of the PDO, the Aleutian Low moves eastward and intensifies, resulting in increased precipitation along the coast of the Gulf of Alaska. SSTs are cooler in the Alaska Gyre but warmer in nearshore waters. During negative phases of the PDO, the central northeastern Pacific warms, the Aleutian Low weakens, coastal precipitation lessens, and nearshore temperatures warm. Longer time-scale fluctuations (centuries to millennia) have occurred repeatedly in the North Pacific climate system (Mann et al., 1999). Studies of coastal tree rings extend the PDO record back to AD 1760 (Wiles et al., 1996, 1998, 199a).

Most of our proxy data for GOA climate prior to AD 1900 come from terrestrial sources (Mann and Hamilton, 1995). Both the Medieval Warm Period (ca. AD 900-1250) and the Little Ice Age (ca. AD 1250-1900) occurred in the GOA region, where they are evidenced by glacier fluctuations and by climatic changes recorded in tree rings (Wiles and Calkin, 1994; Wiles et al., 1998; Wiles et al., 1999 b). Fluctuations in summer temperature of several degrees centigrade are suggested (Wiles et al., 1996). The Medieval Warm Period is especially interesting for us today because it was the last time when global temperatures approached their post-1900 AD levels.

Moving further back in time, the Neoglacial interval (ca. 6000 BP – AD 1900) saw alternating cold and warm intervals each lasting several hundred years to one millennium (Calkin, 1988). Precipitation fluctuated as well, and in combination with temperature changes, caused snowlines to rise and fall by several hundred meters. Transitions from milder to colder conditions during the Neoglacial occurred rapidly in the space of several years to several decades. In general terms, the magnitudes and rates of natural climate changes occurring in the GOA over the last several millennia are similar to those predicted to occur over the next several centuries (Mann et al., 1999). In effect, nature has done a series of experiments in the past about how the GOA ecosystem may respond to future changes in the atmosphere-ocean system.

B. Salmon responses to changes in the atmosphere/ocean system

Climatic shifts have dramatic effects on the biota of the North Pacific, including salmon, at a variety of time scales. Climate variability is linked to ecosystem change in the North Pacific primarily through its forcing effects on lower trophic levels (Francis et al., 1997). These effects work their way through the food web and are modified as they proceed by species' life histories, subsistence strategies, and by top-down effects like predation. Intensification of the Aleutian Low during phases of positive PDO triggers increased zooplankton biomass in the Alaskan Gyre,

probably in response to increased wind-induced upwelling and vertical mixing (Brodeur and Ware, 1992; Brodeur et al., 1996; Sugimoto and Tadokoro, 1997). Phytoplankton and zooplankton populations seem to have increased during the reorganization of upper ocean circulation in response to the 1976/1977 regime shift (Francis et al., 1998).

Some of the most dramatic effects of climatic shifts on the marine biota are evident in the histories of salmon catches (Downton and Miller, 1998). Salmon catches in Gulf of Alaska waters closely track the PDO oscillation, with stock size positively correlated with the average winter/spring strength of the Aleutian Low (Beamish and Bouillon, 1993; Mantua et al., 1997). Northern (Alaskan) and southern (Oregon, California) salmon stocks vary roughly 180° out of phase (Francis and Sibley, 1991; Gargett, 1997).

There is no generally accepted explanation for how the Aleutian Low controls salmon populations in the North Pacific (Francis et al., 1998). One possible explanation is that increased wind mixing stimulates primary productivity in the Alaska Gyre, which provides more food for young salmon during the early marine stages of their lives. Gargett (1997) suggests that the critical link between physical forcing and salmon survival is the enhanced water-column stability in coastal areas during positive PDO phases, which increases primary productivity and subsequently food supply for salmon juvenile stages. Increased stream flow caused by increased rainfall in coastal areas during positive PDO phases may increase spawning success and hatchling survival. Probably all these factors interact to increase salmon stocks during positive phases of the PDO. Historical records are too short to tell us how climate/oceanographic parameters affect salmon populations.

C. Stable Isotopes in lake sediments as records of salmon abundance

Measurements of the natural abundance of stable isotopes make it possible to trace the flow of selected elements in ecosystems (Fry and Sherr, 1984; Owens, 1987; Peterson and Howarth, 1987; Wada et al., 1987). This has application in anadromous Pacific salmon systems because of the dichotomous nature of the two important nitrogen (N) sources, which are marine N from the decay of carcasses of returning adult salmon, and atmospheric N_2 (Kline, 1991). The two sources of N can be distinguished by del^{15}N, which is defined as the per mil difference in $^{15}N/^{14}N$ compared to an air N_2 isotope standard. The premise underlying the use of stable isotope abundance is the relative enrichment of ^{15}N in Pacific salmon (~ +12) in comparison with atmospheric N_2 (0). Food webs based on N_2 fixation tend to be low in ^{15}N (Minagawa and Wada, 1984; Owens, 1987; Wada and Hattori, 1991).

When Pacific salmon return to freshwater to spawn and die, they import significant quantities of marine-derived nutrients. Because these nutrients carry a distinctive signature of heavy nitrogen (^{15}N), the amount of ^{15}N present in the accumulating in the sediments of the spawning lake can be used as a proxy for escapement (Kline, 1991). Studies have quantified the proportion of marine-derived nitrogen (MDN) released by adult salmon as a result of spawning migration (Kline et al., 1993). Measurable shifts in the MDN content of juvenile sockeye have been observed between years of strong and weak escapement. The N-isotope composition of lake biota reflects the recent history of MDN import into the lake ecosystem (Kline et al., 1993; 1994). In some lakes, this signal is transferred to the underlying sediments. Downcore changes in the abundance of MDN can reflect changes in the number of returning adult salmon (Finney et al., 2000).

D. Preliminary data for this study

Data from Karluk and Frazer Lakes on Kodiak Island indicate that sedimentary del^{15}N effectively tracks sockeye escapement (Fig. 1, Finney et al., 2000). We chose Frazer Lake as a test case for this method, as the lake was a "barren system" isolated by a waterfall from salmon prior to stocking in the late 1950s. Subsequently, a fish bypass was constructed and run size significantly increased, with an average escapement of about 200,000 since 1980 (Blackett, 1979; ADF&G, written comm., 1994). Such a large increase in escapement is clearly recorded by sedimentary del^{15}N (Fig. 1). The enrichment in del^{15}N is significant and strongly supports the hypothesis that sediment del^{15}N is influenced by salmon input of MDN. Similarly, data from Karluk Lake indicate a strong relationship between sediment del^{15}N and salmon escapement (Finney et al., 2000). Karluk Lake, one of the greatest sockeye systems in the world, had historical returns >5 million fish. Escapements averaged more than 1 million fish from the turn of the century until about 1935 but then fell to an average of less than 300,000 in the 1960s and 70s (Fig. 1; Koenings and Burkett, 1987a, ADF&G, written comm., 1994). The sedimentary del^{15}N in Karluk is significantly higher than Frazer, and it is consistent with greater salmon escapement. The large decline in sedimentary del^{15}N of about 3 parts per mil towards the top of the core reflects the decline in escapement in this system since the 1930s. These results indicate that sedimentary del^{15}N provides a valuable tool for reconstructing long-term changes in sockeye abundance.

In 2000 we retrieved four cores each from Solf and Eshamy Lakes in Prince William Sound. Solf is a "barren" lake into which salmon have been recently introduced, and Eshamy Lake naturally supports a vigorous sockeye run (Table 1). Preliminary analysis of one of the Eshamy Lake cores shows a striking del^{15}N record (Fig. 2). We have not obtained any radiocarbon dates from Eshamy Lake yet, though the presence of a shift in vegetation from alder to spruce at 130 cm depth in the core suggests that the core base probably dates to ca. 4000 years B.P. By comparison with previously analyzed lakes (Fig. 1), we judge that Eshamy Lake has the potential to provide an excellent del^{15}N record of sockeye spawning populations. Solf Lake will serve as a control for possible changes in non-salmon (e.g., aerosol) input of del^{15}N into Prince William Sound lakes.

Table 1. Characteristics of Study Lakes

Lake	Region	Lake type	Surface area (km^2)	Escapement (1000s fish)	Escapement/Area (1000s fish/km^2)
Eshamy	Prince William Sound	clear	3.6	40	11.1
Solf	Prince William Sound	clear, *control*	0.7	0	0*
Upper Russian	Kenai River	clear	4.6	75	16.3
Karluk	Kodiak Island	clear	39.5	1,000	25.3
Frazer	Kodiak Island	clear, *control*	16.6	(217)**	(13.1)**

*Stocking began in 1998; fish ladder constructed in 2000.

** Stocking began in 1950s; fish ladder built then.

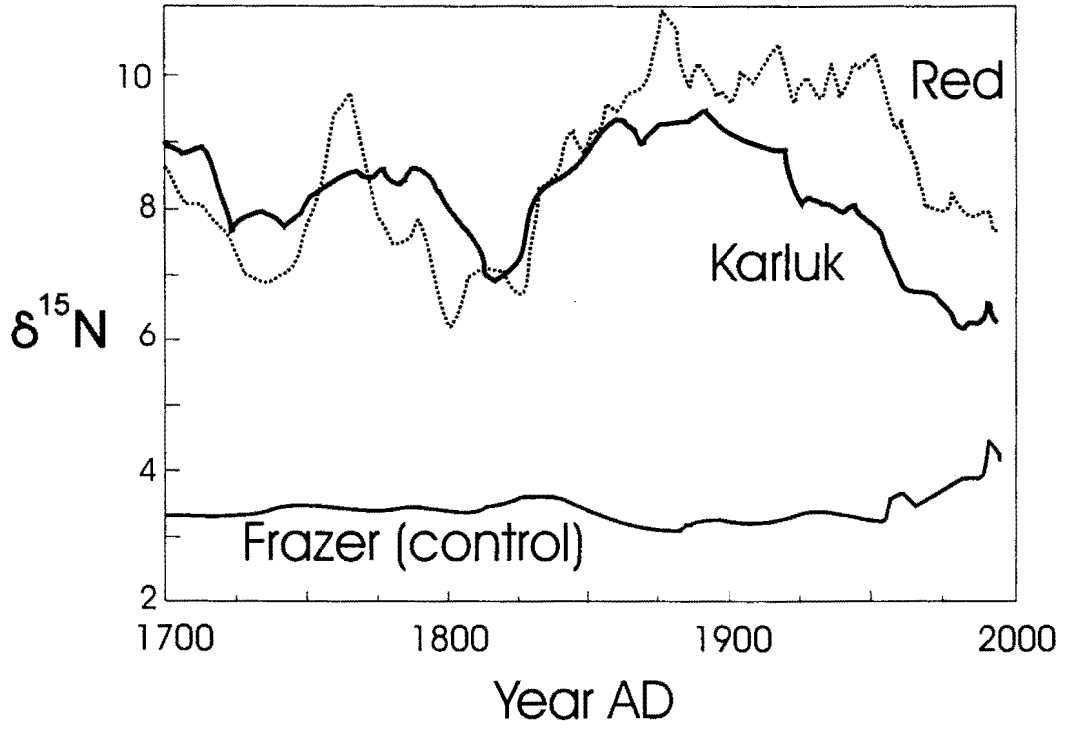

Figure 1. del^{15}N profiles from sockeye and control lakes on Kodiak Island over the past 300 years (Finney et al., 2000). Frazer Lake was barren of salmon until the 1950s, when a fish ladder was built.

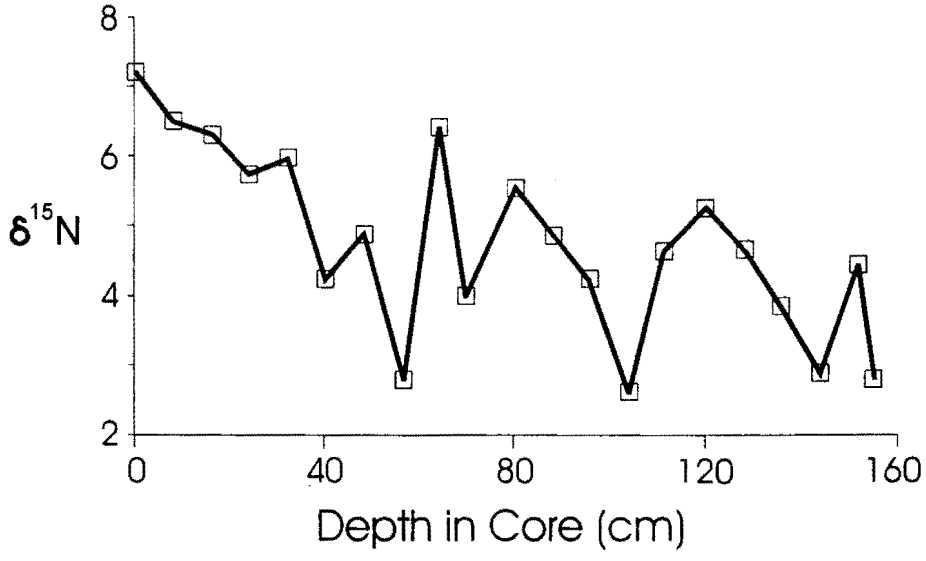

Figure 2. Preliminary del^{15}N profile from Eshamy Lake in Prince William Sound. We suspect this core extends back at least 4000 years. Wide variation in ^{15}N values indicate this lake has excellent potential to provide a high resolution record of salmon population changes.

NEED FOR THIS PROJECT

A. The Problem: What is "normal" for sockeye populations?

The recovery objective set by the EVOS Trustee Council for sockeye salmon is that adult returns-per-spawner should regain normal levels. But what is normal? If both the global environment fisheries management were stable then we might be able to define "normal". But change reigns in both nature and society, and what is normal for the last several decades may be unusual over longer time spans.

The retrospective studies we propose here can establish long-term, baseline records of changes in salmon populations in the GOA. We can use these records to define normalcy by estimating the frequency with which the observed population size occurred in the past. By knowing the extremes of natural population fluctuations in the past, we can identify abnormal population excursions as they occur in the future.

Understanding how environmental factors affect salmon populations is crucial for fisheries management in a time of global change. Also, sockeye may prove to be a useful indicator species for events within the larger GOA ecosystem. Before we can use sockeye as an indicator species, we need to understand how nonhuman factors control their numbers. From retrospective studies, we can generate testable hypotheses about how changes in the atmosphere/ocean system of the GOA will affect salmon populations in the near future. Nature has performed a series of experiments in past millennia, and we can gain access to the results of these experiments through analyses of del^{15}N in lake sediments.

B. Links: Giving GEM a time perspective

The goals of GEM are to detect, understand, and predict ecosystem changes in the GOA with the purpose of informing and assisting resource managers. Besides providing a more rigorous means of defining what is normal, our study will help lay the foundations for GEM by generating hypotheses that relate changes in the atmosphere/ocean system of the GOA to fluctuations in salmon numbers. The past is the key to the present, and climate has varied repeatedly over the last 2000 years. How did sockeye population respond to changes of several C^{o} in the past? The last time temperatures were as warm as today was during the Medieval Warm Period (AD 900-1250). How did sockeye populations respond to this previous warm period?

C. Study Sites

This study involves sockeye lakes in the northern GOA region that were affected by over escapement after the 1989 oil spill. We already have sediment cores from all but one of these lakes. Detailed sediment chemistry has been completed in the two Kodiak Island lakes, Karluk and Frazer (Fig. 2). Preliminary analysis has been done on Eshamy Lake (Fig. 1) in Prince William Sound. The only field work we propose here is to core Upper Russian Lake in the Kenai River watershed in the spring of 2002. We will use Solf Lake on Knight Island as a control for Eshamy Lake. Sedimentary ^{15}N levels in Solf Lake will provide a record of the background level of aerosol input of ^{15}N into PWS lakes. The Solf Lake cores also will be used to test the sensitivity of the ^{15}N method in picking up the first significant entry of anadromous fish into a lake that was barren prior to recent sockeye introductions.

COMMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

Archaeological records contain unsynthesized data concerning the interactions between humans and salmon populations during prehistoric times (see review in Mann et al., 1999). We suspect there is also a rich oral tradition in Native communities about the history and causes of changes in salmon abundance. Within the time constraints of this one-year project, our goals are to get data on sockeye population history and then to develop hypotheses about salmon-climate interconnections. Once we have the science figured out, we want to turn to the local people, the people actually living on the land, to share our ideas and get their ideas back. We anticipate asking EVOS for additional funds in FY 2003 to pay for several trips to Kodiak Island and to villages in PWS and on the Kenai Peninsula, where we will give brief presentations showing our results and initiate conversations about what factors control salmon populations in the GOA region.

PROJECT DESIGN

A. Objectives

We intend to reconstruct sockeye abundance in Eshamy and Upper Russian Lakes using established methods of isotope analysis of lake-bottom sediments that are retrieved by coring. The specific objectives of this study are:

1) Develop sediment-core chronologies and measure downcore changes in lake- productivity indicators (organic C and C/N ratios) as well sedimentary del^{15}N.

2) Compare sediment data corresponding to the past few decades (e.g., the period of intensive investigations by ADF&G) to salmon population statistics. We then will develop calibration relationships between del^{15}N and salmon numbers.

3) Reconstruct paleolimnologic changes in each lake over the past several thousand years, using the results of Specific Objectives 1 and 2. Specifically, we will reconstruct time-series of lake productivity, input of marine-derived nutrients, and salmon escapement.

4) Compare del^{15}N records from PWS and the Kenai Peninsula to Finney's published and ongoing work on Kodiak Island. This synthesis will result in a valuable new perspective on changes in sockeye abundance in the GOA at decadal time scales over the last several millennia.

5) Compare reconstructed sockeye population fluctuations with published data sets on paleoclimatic changes in the GOA region. These data sets include tree rings, glacial records, and pollen records of vegetation change. From these comparisons, we will develop a series of hypotheses about how changes in the atmosphere/ocean system affect salmon populations.

B. Methods

1) Sediment cores

We already have cores from Eshamy, Solf, Karluk, and Frazer Lakes. Upper Russian Lake will be cored for the first time in this study. Existing cores from Karluk and Frazer Lakes that extend deeper than ones already described by Finney et al. (2000) are currently being analyzed in

another project. The Kodiak cores will cover the same time scales as present in the Eshamy Lake record and, hopefully, as in the Upper Russian record.

Coring sites are identified from bathymetric maps, and sites are selected to avoid gravity-flow deposition and complicated bottom topography. We will obtain at least two, 1- 2 m long cores using the percussion corer that we built last year to obtain cores from Eshamy and Solf Lakes. High quality surface cores will be obtained with a device (Glew corer) designed for sampling unconsolidated sediments and obtaining an undisturbed sediment-water interface. The cores will be stored in a cold room and excess material archived for future studies.

Cores will be described for lithology, texture, color, and other properties, and photographed. Each core will be continuously scanned for magnetic susceptibility. Magnetic susceptibility, a measure of the abundance of magnetic minerals, provides important stratigraphic and sedimentologic information (e.g., King et al., 1983). For example, magnetic susceptibility is sensitive to volcanic ash abundance; visually undetected ashes often are easily detected in susceptibility profiles. Ash layers should be common in many of the lakes, given the close proximity to active volcanoes, and they are useful for correlating between cores and between different lakes. Sediment chronologies will be determined by a combination of ^{210}Pb-dating (Bruland et al., 1974) in the upper several tens of centimeters and by AMS-^{14}C dating of terrestrial plant macrofossils in sediments older than several centuries.

2) Reconstructing changes in sockeye salmon abundance

Changes in input of marine-derived nutrients (MDN) will be determined by analysis of del^{15}N. As discussed earlier, downcore changes in the abundance of MDN (from del^{15}N) reflect changes in the number of returning adult salmon, and thus is a proxy for escapement. Organic carbon content, C/N ratio, and del^{13}C also indicate changes in organic matter source (Hedges and Parker, 1976; Meyers, 1990). Time-series of organic C content, C/N ratios, and stable C and N isotopes will shed light on changes in the source and supply rate of organic matter. We will calibrate our MDN-based reconstructions in sockeye salmon escapement with recorded escapement records. The lakes we propose to study have had significant changes in escapement during the past few decades. These variations allow us to determine how well sedimentary del^{15}N reflects escapement (e.g., Fig. 1). Using recent calibrations, we will estimate prehistoric escapements from downcore changes in del^{15}N.

C. Cooperating agencies, contracts, and other agency assistance

Though no formal collaborations are planned with federal agencies within this brief project, in fact we are collaborating closely with ADF&G and USFWS in ongoing, similar studies of salmon paleoecology (e.g., Schmidt et al., 1997).

SCHEDULE

A. Project Tasks and Endpoints

December 31, 2001:	Complete del^{15}N analyses on Eshamy Lake and Solf Lake (control) cores; submit samples for ^{14}C and ^{210}Pb dating.
January, 2002:	Present preliminary results at Restoration Workshop and discuss their implications for design of GEM monitoring studies.

mid-March, 2002:	Core Upper Russian Lake.
April, 2002:	Submit annual report to EVOS.
June 30, 2002:	Complete del^{15}N analyses on cores from Upper Russian Lake; submit samples from this lake for ^{14}C and ^{210}Pb dating.
July 31, 2002:	Complete literature reviews of proxy data describing climate/oceanographic changes in the northern GOA over the last several millennia. Develop hypotheses relating changes in salmon populations to climatic changes.
September 1, 2002:	Submit manuscript for publication in peer-reviewed journal concerning the applications of retrospective records of sockeye populations in fisheries management.
October 1, 2002:	Submit manuscript for publication in peer-reviewed journal concerning climate-oceanographic drivers of salmon populations in the GOA region. Also, develop a public lecture aimed at informing communities in the GOA region about our research.
December 7, 2002:	Present major finding at the American Geophysical Union Fall meeting.
January, 2003:	Present results and discuss implications for GEM projects at Restoration Workshop.
April, 2003:	Submit final report to EVOS.

PUBLICATIONS AND REPORTS

We plan on two publications published in peer-reviewed scientific journals. The first one concerns the use of retrospective data on sockeye salmon escapement inferred from lake-sediment records in fisheries management. Possible journals are *Fisheries Oceanography* and *Canadian Journal of Fisheries and Aquatic Science.* Our second publication will concern the connections between salmon populations and climatic change in the Gulf of Alaska region. Our target journal for publication is *Journal of Geophysical Research.*

PROFESSIONAL CONFERENCES

We will present our results at two scientific meetings, the American Geophysical Union meeting in San Francisco and a meeting of the American Fisheries Society.

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2001 EXXON VALDEZ TRU COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2003	Proposed FY 2002	LONG RANGE FUNDING REQUIREMENTS					
					Estimated FY 2003	Estimated		
Personnel		$0.0						
Travel		$0.0						
Contractual		$96.1						
Commodities		$0.0						
Equipment		$0.0						
Subtotal		$96.1						
General Administration		$6.7						
Project Total		$102.8			$0.0			
Full-time Equivalents (FTE)		0.4						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1. Indirect costs at 25% as agreed with the University of Alaska Fairbanks.
2. 4% of direct cost will be spent on attending workshops and professional meetings.
3. Total project cost including 7% agency general administr tion (ADFG) will be $6.7
4. Publication cost-$4,000 to be submitted to Fisheries Oceanography and Canadian Journal of Fisheries and Aquatic Science and Journal of Geophysical Research.

FY02

Prepared:4/7/00

Project Number: 02649
Project Title: Reconstructing Sockeye Populations in the Gulf of Alaska over the Last Several Thousand Years: The Natural Background to Future Changes.
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

4/10/01

2001 EXXON VALDEZ TRU COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001
Personnel		$40.1
Travel		$6.6
Contractual		$23.2
Commodities		$7.0
Equipment		$0.0
Subtotal		$76.9
Indirect		$19.2
Project Total		$96.1
Full-time Equivalents (FTE)		0.4

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2003	Estimated		
		$0.0			

Dollar amounts are shown in thousands of dollars.

Other Resources

Comments:

The indirect rate is 25% TDC, as negotiated by the Exxon Valdez Oil Spill Trustee Council with the University of Alaska.

(Use this statement if there is a graduate student tuition and use proper resident or non-resident amount)

FY02

Prepared:4/7/00

Project Number:
Project Title: Reconstructing Sockeye Populations in the Gulf of Alaska over the Last Several Thousand Years: The Natural Background to Future Changes.
Name: D. H. Mann and B. Finney

FORM 4A
Non-Trustee
SUMMARY

WMF 4/10/01

2001 EXXON VALDEZ TRU COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2000
	Mann	PI	3.0	9.1		27.3
	Finney	Co-PI	1.0	7.4		7.4
	Krumhardt	Technician	1.0	5.4		5.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	5.0	21.9	0.0	
					Personnel Total	$40.1

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2001
	Fbks to Anchorage	0.25	8	8	0.1	2.8
	Fbks to Upper Russian Lake	0.5	2		0.5	1.0
	Fbks to AGU meeting San Francisco	0.6	1	4	0.2	1.4
	Fbks to Lower 48 city	0.6	1	4	0.2	1.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$6.6

FY02

Prepared:4/7/00

Project Number:
Project Title: Reconstructing Sockeye Populations in the Gulf of Alaska over the Last Several Thousand Years: The Natural Background to Future Changes.
Name: D. H. Mann and B. Finney

FORM 4B
Personnel
& Travel
DETAIL

4/10/01

2001 EXXON VALDEZ TRU COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:	Proposed
Description	FY 2001
Laboratory analyses of N and C isotopes	6.0
AMS-radiocarbon dating, 20 samples @ $500/ea.	6.0
210Pb analyses, 3 @ $2000/ea.	10.0
Ski-plane charter, Kenai to Upper Russian Lake, 4 hrs	1.2
Contractual Total	$23.2

Commodities Costs:	Proposed
Description	FY 2001
Material misc. cord, cable and rope for the corer and laboratory glasware for Dr. Finney's work.	2.5
Publications	4
Communications and copies	0.5
Commodities Total	$7.0

FY02

Prepared:4/7/00

Project Number:
Project Title: Reconstructing Sockeye Populations in the Gulf of Alaska over the Last Several Thousand Years: The Natural Background to Future Changes.
Name: D. H. Mann and B. Finney

FORM 4B
Contractual & Commodities DETAIL

WMF 4/10/01

2001 EXXON VALDEZ TRU COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2001
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	

FY02

Prepared:4/7/00

Project Number:
Project Title: Reconstructing Sockeye Populations in the Gulf of Alaska over the Last Several Thousand Years: The Natural Background to Future Changes.
Name: D. H. Mann and B. Finney

FORM 4B
Equipment
DETAIL

4/10/01

LINKS BETWEEN PERSISTENT OIL IN MUSSEL BEDS AND PREDATORS

Project Number: ~~02xxxx~~ 02652

Restoration Category: Research

Proposers: Dr. Stan Rice- NOAA Auke Bay Laboratory, ABL Program Manager
Dr. Thomas A. Dean- Coastal Resources Associates, Inc., President
Dr. Stephen Jewett- UAF/SFOS, Research Professor

Lead Trustee Agency: NOAA

Cooperating Agencies: none

Alaska SeaLife Center: No

Duration: 1 year project

Cost FY 02: $53,465 - UAF

Cost FY 03: $25,300 - UAF

Geographic Area: Prince William Sound

Injured Resource/Service: Intertidal communities, sea otters, harlequin ducks

ABSTRACT

Links between oil-contaminated mussel beds and impacts on infauna and vertebrate predators have been inferred, but have not been definitively demonstrated. Significant oil concentrations in some mussel beds have persisted to present, much longer than originally expected, and may explain contemporary observations of vertebrate predator exposure to oil. The possibility that oiled beds are long-term sources of vertebrate contamination was unanticipated, and has implications for future monitoring and response decisions in the event of future spills. In a more holistic approach than in the past, several research groups will examine evidence for links between persistence of Exxon Valdez oil in mussel beds, infauna, and in nearshore vertebrate predators.

INTRODUCTION

High concentrations of Exxon Valdez oil have persisted in some oiled mussel beds within the spill region for 10 years (Babcock et al. 1998, Carls et al. 2001). Recent evaluations suggest that average oil concentrations in sediment have declined over the past several years (from 1994 through 1999). However, total polynuclear aromatic hydrocarbon (TPAH) concentrations ≥ 31 $\mu g\ g^{-1}$ dry sediment still persisted in about 1/3 of oiled mussel beds surveyed in 1999, and projections suggest contamination will persist in some beds for several decades. This persistence was not anticipated when decisions were made in 1989-90 NOT to clean mussel beds, and in fact raises the question of whether a few very persistent mussel beds should now be cleaned.

The relevance of persistent oil in mussel beds is that contaminated beds may be the contemporary source of vertebrate exposure to oil. There is evidence of oil exposure and continued injury to sea otters and harlequin ducks that feed on mussels and associated fauna (Bodkin et al. 1999, Esler et al. 2000, Trust et al. 2000), and more recently to masked greenling (Jewett et al. In Review). These, as well as one other species that feed on mussels, Barrow's goldeneye, were exposed to oil as indicated by elevated levels of cytochrome P450-1A (Ballachey et al. 1999). Feeding on mussels or other contaminated prey in oiled mussel beds is a likely route of exposure in nearshore vertebrate predators, and exposure to oil is a likely cause for lack of total recovery for these species (Ballachey et al. 1999, Bodkin et al. 1999, Esler et al. 2000, Trust et al. 2000). However, there is no direct evidence to link exposure of vertebrates to feeding in oiled mussel beds. These are different mobile species to work with.

The concentrations of oil in some oiled mussel beds in 1999 were also high enough to be of concern to associated infauna. While there is little evidence of impacts of oil on population density or physiology of mussels (Thomas et al. 1999) other species in the mussel community are much more sensitive to oil (e.g., Dauvin et al. 1982, 1998, Jewett et al. 1999). Benthic communities from sites with concentrations of TPAH in excess of 34 $\mu g\ g^{-1}$ are generally impacted by exposure to oil (Long and Morgan 1990, Long 1992). In 1999, 8 of 26 oiled mussel beds had TPAH concentrations in sediments that were in excess of 34 $\mu g\ g^{-1}$ (Carls et al. 2001). Also, subtidal benthic communities at sites that were oiled after the Exxon Valdez oil spill were adversely impacted by the spill (Jewett et al. 1999) yet TPAH concentrations were much lower than observed in oiled mussel beds in 1999 (Jewett et al. In Review). These data suggest that infauna associated with oiled mussel beds may be impacted by continued exposure to oil. However, there has been no direct investigation of the impacts of oil in oiled mussel beds on associated infauna, either in population diversity, or hydrocarbon loads. These data are needed to evaluate interaction and risk with vertebrate predators.

Oiled beds will be chosen from previously studied beds where contamination levels are projected to persist for long periods of time, and within areas where vertebrate predators are expected. Hydrocarbon concentrations in sediment and mussel tissue will be determined at each site. The prey base (species diversity) will be examined, along with hydrocarbon loads in the more common species. Links to vertebrate predators will be examine in two ways: (1) vertebrate predator activity will be recorded in the winter and spring using a remote video system, and (2) mixed function oxidase enzyme activity [cytochrome P450-1A as ethoxyresorufin O-deethylase (EROD)] will be measured in masked greenling caught at each site and (3) fluorescent aromatic compounds (FACs) will be measured in selected masked greenling from each site. Based on

recent results, this species now appears to be the most likely to demonstrate a link of vertebrate predators to oiled mussel beds.

Masked greenling still show evidence of exposure, as shown in Figure 1 where elevated EROD activity was measured in both oiled and unoiled areas of Prince William Sound (Jewett et al. In Review). This species may not be an ideal species, as it's range is not restricted to mussel beds, but probably has less range than higher profile species such as sea otters and sea ducks. Attempts will be made to link prey species in the diet of masked greenling with infauna prey species collected in the oiled mussel beds. Further, the hydrocarbon exposure measurements (EROD, and biliary FACs) will be repeated, but with the balanced 5-oiled and 5-unoiled to determine if there are differences between oiled areas and non-oiled areas.

Linking vertebrate predators to contemporary oil is a difficult task, which becomes more difficult with each passing year. Some oil persists, in a toxic form, but do vertebrate predators feed in these areas? If so, when? If so, how much? Is that exposure enough? Most of these questions will remain unanswered. This project will likely be the last attempt to link known oiled areas with prey and with vertebrate predator exposure. In some respects, it is a fishing trip of sorts, but the linkage issue is a nagging issue that deserves direct attention, rather than a secondary level of attention. The last effort of this project will by a synthesis of the linkage issue, which will combine the information from this study with the results from the comprehensive general survey for remaining oil in PWS, a separate project proposed for summer 2001.

NEED FOR THE PROJECT

A. Statement of Problem

Several nearshore vertebrate predators and some intertidal communities have failed to show clear signs of full recovery 10 years after the Exxon Valdez Oil Spill. The continued injury to several nearshore vertebrate predator species is likely due to continued exposure to Exxon Valdez oil. High concentrations Exxon Valdez oil persisted in several mussel beds within heavily oiled portions of Prince William Sound as of summer 1999. Several of the injured nearshore vertebrate species (e.g., sea otters and harlequin ducks) and other species for which there is evidence of continued exposure to oil (e.g., Barrow's goldeneyes and masked greenlings) feed on mussels and/or associated fauna (McConnaughey 1978; Blackburn et al. 1983; Rosenthal 1983; Jewett et al. In Review). In June 1999, the stomach contents of 23 adult masked greenling collected adjacent to oiled mussel beds were examined. Dominant prey, in decreasing frequency of occurrence, were crabs (Pagurus, Telmessus, Cancer), benthic amphipods, and shrimps (Pandalus) (Jewett, unpubl.). Some of these prey are also consumed by sea otters and harlequin ducks. Thus, oil in mussels, other associated prey species, or in associated sediments are likely sources of contamination of nearshore vertebrates. For some of these beds, oil is projected to persist for several decades, and hence be a potential source and threat for predators to cope with. Links between oiled mussel beds and predators were never anticipated, and have not been studied directly. Persistence of oil in beds has been studied (last sampled in 1999), and vertebrate species recovery has been monitored, but the link between mussel beds and vertebrate predators is inferential rather than direct. Future decisions to clean some Prince William Sound

mussel beds, or to clean beds after potential future spills need further study to support these decisions.

B. Rationale/Link to Restoration

Continued injury of nearshore vertebrate predator species appears to be caused by exposure to oil, and persistent oil in mussel beds is a likely source of contamination. If the hypothesis that mussel beds serve as sources of oil for nearshore vertebrate predators, further cleanup of oiled beds may be warranted as a means of accelerating recovery of the nearshore ecosystem. Future cleanup of oiled mussel beds, or beds after potential future spills can only be justified if natural restoration is inadequate or too slow, and there is a linkage between these beds and other fauna, including predators.

C. Location

The proposed study will be conducted in Prince William Sound.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

The proposed study will extend Trustee-sponsored research conducted during the damage assessment and restoration phases of the Exxon Valdez Oil Spill. Past work has been presented at various public meetings sponsored by the council. Manuscripts produced will likely be the basis of future presentations at Trustee sponsored restoration workshops.

PROJECT DESIGN

A. Objectives

For each of 5 oiled and 5 reference mussel beds:

1. Determine hydrocarbon loads:
   a) Sediment and mussel tissue from mussel beds.
   b) Hydrocarbon concentrations in representative infauna prey.

2. Determine impacts on fauna:
   a) Infauna species diversity will be determined in the same 10 mussel beds.
   b) Macrofauna abundance and community structure
   c) Determine growth/size structure of mussels between oiled and unoiled beds.

3. Evaluate potential links to vertebrate contamination:
   a) Measure hydrocarbon exposure in masked greenling by measuring cytochrome P450-1A (EROD) and biliary FACs from the same 10 mussel bed areas.

4. Re-evaluate the contribution potential of oiled mussel beds as links to nearshore vertebrate predators.

B. Methods

Design Overview

A balanced design approach will be utilized; 5 oiled and 5 unoiled mussel beds will be examined. Concentrations of total polynuclear aromatic hydrocarbons (TPAH) (in both sediments and mussel tissue) will be determined and correlated with a series of impact measurements ranging from prey contamination, to infauna species diversity, to vertebrate exposure measurements. Infauna associated with mussel beds will be characterized in five oiled mussel beds and five unoiled reference sites within Prince William Sound. These sites will be chosen based on 1999 sediment and mussel hydrocarbon results from the mussel bed restoration project (Figure 2). Hydrocarbon analysis in sediment will typically be completed by ultraviolet fluorescence, and GC/MS analysis of sediment will be restricted to verification of sources of hydrocarbons at each site. Oiled sites will be chosen from those where 1) sediments and mussel tissue have previously been sampled, 2) sediment TPAH concentrations were above 30 $\mu g\ g^{-1}$ in 1999 (Harris, unpublished data), 3) contamination levels are projected to persist for long (decadal) periods, and 4) vertebrate predator utilization is expected, particularly masked greenling. Reference sites will include one that was sampled in 1999 (Barnes Cove) and 4 additional sites to be selected based on a preliminary survey. Reference sites will be located along unoiled shorelines within the Knight Island/Naked Island region. Sites will be selected that match the oiled mussel beds with respect to physical characteristics other than oil, including slope, exposure, aspect, and substrate type.

The mussel beds at each site will be mapped as described by Babcock et al. (1998). In general, selected beds will be about 5 x 5 m (25 m^2) or more in size. Previous sampling at several representative beds indicated that hydrocarbon concentration in sediment can vary up to two orders of magnitude within a few meters, with some correlation with elevation ($r^2 = 0.65$) (Babcock et al. 1998). Accordingly, sample collection will be stratified by elevation, but randomized within elevation.

1. Hydrocarbon loads in sediment, mussel tissue, and crabs

(1a) Sampling of hydrocarbons will be designed to inspect both intra- and inter-bed variation, and allow correlation of sediment, mussels and infauna at specific spots within each bed. Previous research demonstrated some correlation between elevation and oil concentration in sediment ($r^2 = 0.65$, Babcock et al. 1998), thus sampling will be stratified by elevation. Transects will be placed at two vertical elevations spaced in parallel 2 m apart, and 3 spots selected at random along each transect will be sampled from each transect. The samples will be collected and analyzed as described in Babcock et al. (1998). A 0.25 x 0.25 m quadrate will be centered on each collection spot. At least 10 g of mussels will be frozen for hydrocarbon analysis. All predatory snails (primarily Nucella lammelosa and Nucella lima) will be counted within the quadrates. Sediment under the mussel layer will be collected for hydrocarbon analysis, grain size and total organic carbon content.

(1b) Representative samples of amphipods and crabs (primarily Telmessus cheiragonus) will be collected from each site for determination of TPAH concentrations within their tissues.

The animals will be collected by hand or from sediments shoveled from each site and sieved. All animals will be collected from an area between the mussel bed and MLLW. A sufficient number of animals will be collected to obtain a 10 g sample of each species.

2. Oil impacts on fauna.

(2a) Benthic invertebrates will be collected from a 10-cm diameter by 10-cm deep core sample at each randomly chosen spot described above. The cores will be preserved in formalin and returned to the laboratory for sorting and analysis. Samples will be sieved through a 1-mm mesh, and the animals identified and counted. Organisms will be identified to at least the family level, and analyzed to species for more commonly encountered species.

(2b) Larger invertebrate predator species will be counted at each site. A 50-m long stretch of shoreline will be delineated at each site with the mussel bed in the center. Counts will be made during a falling tide to minimize the chance of not counting animals that retreat to the subtidal zone during periods of low tides. The area censused will be measured at each site so that the number of animals per unit area (density) can be determined.

(2c) Mussels (0-5 mm grouped for recruitment and >5 mm) from the hydrocarbon sampling quadrates (see 1a. methods) will be counted to estimate mussel density and measured to estimate size distributions in each bed at each site.

3. Evaluate potential links to vertebrate contamination

(3a) Masked greenling will be captured by hook and line, baited pots, or seine net at high tide in the vicinity of each selected mussel bed (8 per site) and analyzed for 1) tissue hydrocarbons [by gas chromatograph/mass spectroscopy GC/MS], 2) cytochrome P450-1A (EROD) activity in liver, 3) hydrocarbon metabolites in bile (FACs). Livers and bile will be collected and frozen for analyses. Stomachs will be removed and preserved for prey analysis. Remaining tissues will be frozen for potential GC/MS analysis. These measures of hydrocarbon concentration or exposure will be compared to mean hydrocarbon concentrations in sediment, mussels, and infauna by site to determine possible correlations.

Data analysis

We will test the null hypothesis of no significant difference between oiled and reference sites using analysis of variance (ANOVA). Metrics to be tested in this manner will include: 1) hydrocarbon concentrations in sediments, 2) TPAH concentrations in mussels, masked greenling, amphipods, and other selected fauna, 3) the density of dominant taxa within core samples, 4) the density of dominant sea stars and other invertebrate predators, and 5) EROD activity in livers and FACs in bile from masked greenling. The analysis of dominant benthic invertebrates may use sediment grain size as a covariate if appropriate.

We will also examine possible correlations between all measured variables. For correlations of mussel TPAH, sediment hydrocarbon concentrations, and density of dominant benthic invertebrates within cores we will conduct separate analyses using both cores and sites as

sampling units. Correlation between FAC and EROD assays will be done using individual fish as the sampling unit. For all other metrics, site means will be used as sampling units.

A time series of mussel and sediment hydrocarbon concentrations will be plotted for each site for which there are historical data (all five oiled sites and one reference site). In addition, concentrations averaged across beds will be determined to describe regional trends and the average 'half-life' of oil in these mussel beds.

Personnel and project management

The project will be conducted by a team of scientists who have been directly involved in the studies of the nearshore system in Prince William Sound since 1989. The work will be coordinated by Dr. Stanley Rice of the NOAA Auke Bay Laboratory. Dr. Thomas Dean, President of CRA will serve as project leader for fish and invertebrate studies. Pat Harris and Mandy Lindeberg will direct studies of contamination in mussels and sediments. Dr. Stephen Jewett will direct the laboratory workup of benthic invertebrates in core samples and the processing of fish tissues. Jeff Short will oversee hydrocarbon analyses, Mark Carls will assist with sampling design, analyses and writing. Cytochrome P450-1A expression (EROD) in fish tissues will be conducted at Woods Hole Oceanographic Institution. Analysis of biliary FACs will be conducted through NOAA.

Responsibilities for each of the contractors is as follows:

NOAA Auke Bay Laboratory (PI J. Rice, P.Harris, M. Lindeberg)
- Manage and Direct the Project
- Assist in manuscript preparation
- Provide for all logistical support for field sampling efforts
- Conduct all hydrocarbon and biliary FACs analyses

Coastal Resources Associates, Inc. (PI Dean)
- Manage field sampling
- Assist in sampling and data analysis
- Assist in manuscript preparation

University of Alaska, Fairbanks (PI Jewett)
- Assist in sampling
- Do laboratory analysis of benthic samples
- Prepare, catalogue, ship, and enter fish tissue data
- Assist in manuscript preparation

C. Cooperating Agencies, Contracts, and Other Agency Assistance

This proposal is being submitted by NOAA. However, a portion of the funding will probably be directed to under BAA by Coastal Resources Associates, Inc. and to the University of Alaska.

SCHEDULE

A. Measurable Project Tasks for FY 02 (October 1, 2001 - September 30, 2002)

January 2002	Annual Workshop, finalize sampling design
July 2002	Complete sample collection
October 2002	Progress report
March 2003	Complete chemical, infauna, and masked greenling analyses
June 2003	Complete statistics
August 2003	Complete report

B. Project Milestones and Endpoints

All fieldwork will be completed by July 2002, and all field data will be entered and databases established by September 30, 2002. Laboratory analysis of benthic infauna, hydrocarbon and CYP1A data will be completed by March 1, 2003. A draft final report will be submitted by July 1, 2003. Results of this study will be presented at the annual EVOS workshop in Jan 2004 and that manuscripts will be finalized in FY2004.

C. Completion Date

Except for peer-reviewed publication and presentation at the annual EVOS workshop, the project will be complete by September 2003.

PUBLICATIONS AND REPORTS

A progress report will be submitted to the Trustee Council in October 2002 summarizing field sampling efforts of the previous summer.

Three manuscripts will be prepared and will serve as the final report for the project. Anticipated titles, authorship, and journals for submission are as follows:

Oiled mussel beds: a source of continued contamination of nearshore vertebrates 13 years after the Exxon Valdez Oil Spill. S Rice, T Dean, S Jewett, M Carls, P Harris, M Lindeberg, (anticipated submission to Marine Ecology Progress Series or Marine Pollution Bulletin).

Altered communities in oiled mussel beds 13 years after the Exxon Valdez oil spill. T Dean, S Jewett, P Harris and M Lindeberg (anticipated submission to Marine Ecology Progress Series or Marine Pollution Bulletin).

Linking oiled mussel beds as a persistent source of contamination to predators and their prey 13 years after the Exxon Valdez oil spill - S Rice, T Dean, S Jewett, M Carls, P Harris, M Lindeberg, J Stegeman. (anticipated submission to Marine Ecology Progress Series or Marine Pollution Bulletin as a synthesis).

PROFESSIONAL CONFERENCES

No funding is being requested for attendance at professional conferences in FY02.

NORMAL AGENCY MANAGEMENT

NOAA/NMFS has statutory stewardship for most living marine resources; however, if the oil spill had not occurred, NOAA would not be conducting this project. NOAA/NMFS proposes to make a significant contribution (as stated in the proposed budget) to the operation of this project, making it truly cooperative.

This project has been developed through collaboration of NOAA, private sector, and the University of Alaska scientists. None of the proposers have management responsibility. However, it is anticipated that publications produced will be widely utilized in future management decisions.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The scientists involved in the preparation of manuscripts have worked collaboratively in previous Trustee funded investigations of injury and recovery in coastal habitats.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

None

PROPOSED PRINCIPAL INVESTIGATOR - UAF

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BIOGRAPHICAL SKETCHES FOR PRINCIPAL INVESTIGATORS

Dr. Stanley Rice, GM-14 physiologist, has been Habitat Program Manager of NOAA/NMFS/Auke Bay Laboratory since 1986. Dr. Rice has conducted and managed Exxon Valdez damage assessment and restoration sudies since 1989 including cooperative projects with other agencies, and providing critical reviews and input in agency decisions. He has over 20 years experience researching oil effects encompassing a wide variety of organisms and conditions.

Dr. Thomas A. Dean is President of the ecological consulting firm Coastal Resources Associates, Inc. (CRA) in Vista, CA. Dr. Dean has over 20 years of experience in the study of nearshore ecosystems, and has authored over 30 publications, including several dealing with impacts of the Exxon Valdez oil spill on nearshore plants and animals. He has extensive experience in long-term monitoring studies, and has played a major role in both intertidal and subtidal EVOS investigations since 1989.

Dr. Stephen C. Jewett has been a researcher at the School of Fisheries and Ocean Science, University of Alaska Fairbanks, since 1975. He currently serves as Research Professor. During this time he has been involved in numerous benthic and intertidal investigations throughout Alaska that emphasize assessment and/or monitoring. He has authored more than 30 publications in scientific journals and books. He has been the coordinator of the federal/state EVOS shallow subtidal investigations in Prince William Sound (1989-1999). He most recently conducted an EVOS investigation on the lingering effects of the spill to nearshore fishes (Project 00379; Jewett et al. In Review).

Patricia M. Harris has been involved in Exxon Valdez oil spill research since March 1989; as a co-principal investigator for NRDA project Subtidal 3, Mussel bed monitoring and restoration, and Pristane monitoring in mussels, she has been responsible for study design, field logistics, sample collection and assisted in data analysis and proposal and report preparation.

Mandy R. Lindeberg has been involved in Exxon Valdez oil spill research for the last 10 years. Her research includes intensive studies on intertidal invertebrates and seaweeds, mussel populations, and currently she is a co-principal investigator of spot shrimp populations in Prince

William Sound. Her responsibilities include quality control of field and laboratory sample processing, data analysis, graphics, and proposal and report preparation.

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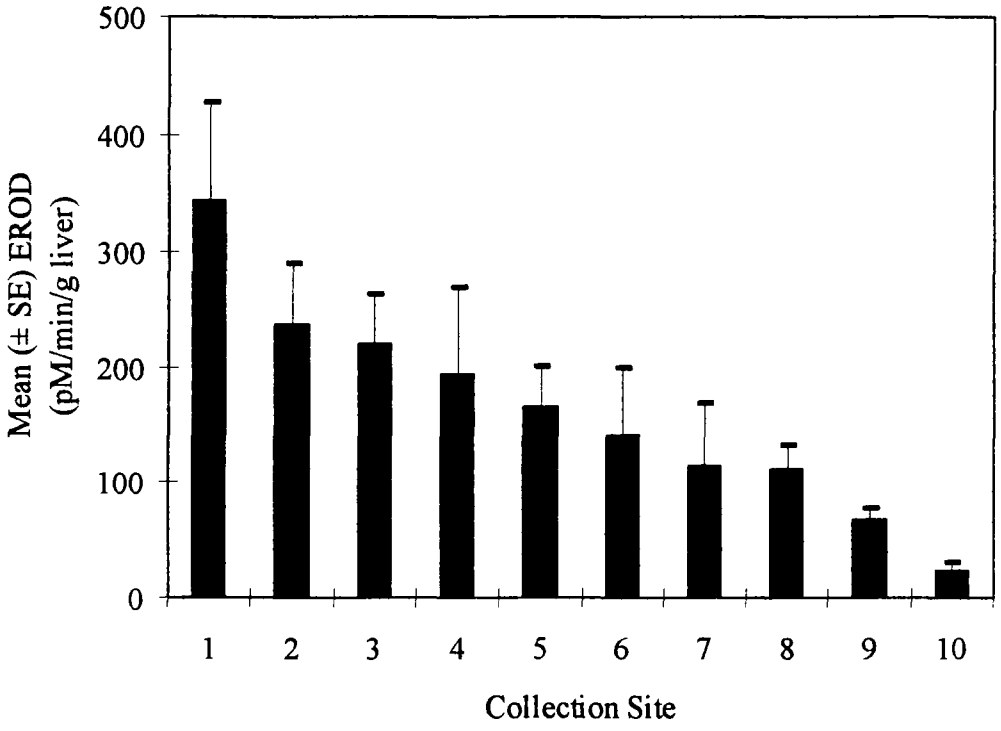

Figure1. Inter-site differences in mean EROD values in masked greenling, Prince William Sound 1999. P-values are presented and values significantly different are in bold.

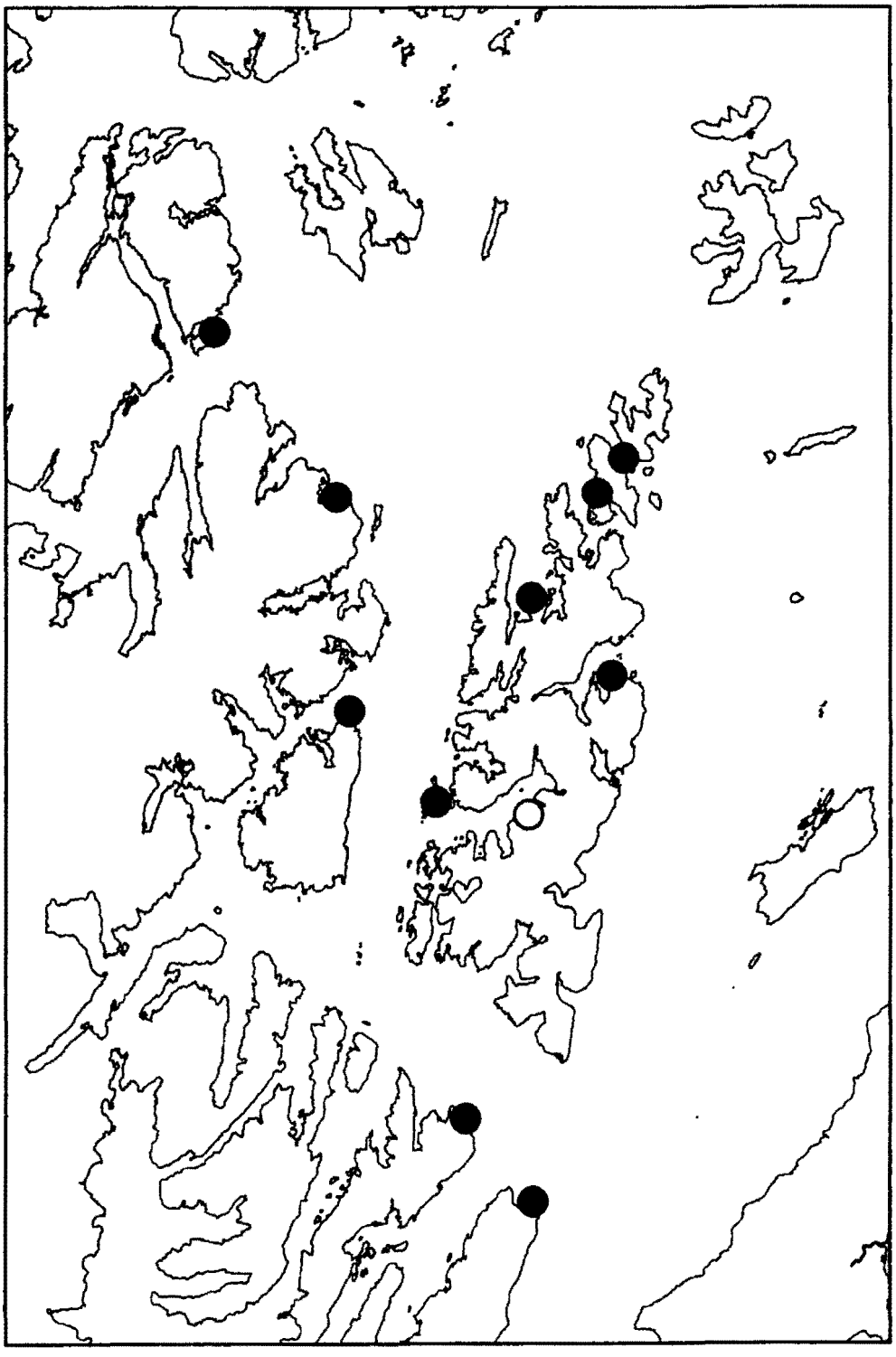

Figure 2. Oiled mussel beds in PWS to be used as candidates for sampling.

BUDGET SUMMARIES By task and affiliation (without GA)

Task	NOAA		CRA		UAF	
	FY02	FY03	FY02	FY03	FY02	FY03
1a	$33.1	$28.7	$1.0	-	-	-
1b	-	$15.6	$4.0	-	-	-
2a	-	-	-	-	$16.4	-
2b	-	-	$5.3	$3.7	-	-
2c	$4.0	$5.1	-	-	-	-
3a	-	$4.7	-	-	$25.8	$9.8
4	$11.2	$16.3	$13.8	$17.8	$0.6	$10.4
Total	$48.3	$70.4	$24.1	$21.5	$42.8	$20.2

2002 *EXXON VALDEZ* TI EE COUNCIL PROJECT BUDGET

October 1, [illegible] · September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002						
Personnel		$0.0						
Travel		$0.0						
Contractual		$53.4						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$53.4	Estimated FY 2003					
General Administration		$3.7						
Project Total		$57.1						
Full-time Equivalents (FTE)		0.4						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY02

Prepared:

Project Number: ~~02xxx~~ 02652
Project Title: Links between persistent oil in mussel beds and predators
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2002 *EXXON VALDEZ* T TEE COUNCIL PROJECT BUDGET

October 1, ___ . - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002						
Personnel		$29.6						
Travel		$1.8						
Contractual		$10.9						
Commodities		$0.4						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$42.7	Estimated FY 2003					
Indirect		$10.7						
Project Total		$53.4	$25.3					
Full-time Equivalents (FTE)		0.4						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

The indirect rate is 25% TDC, as negotiated by the *Exxon Valdez* Oil Spill Trustee Council with the University of Alaska.

FY02

Prepared:

Project Number: 02xxx
Project Title: Links between persistent oil in mussel beds and predators
Name: Stephen C. Jewett

FORM 4A
Non-Trustee
SUMMARY

2002 *EXXON VALDEZ* TR EE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 2002
Jewett, S.	PI/Research Professor		2.3	8.1		18.2
Hoberg, M.	Technician		2.3	5.1		11.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
Subtotal			4.6	13.2	0.0	
					Personnel Total	$29.6

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2002
Fairbanks to Anchorage	440.0	3	4	120.0	1.8
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.8

FY02

Prepared:

Project Number: 02xxx
Project Title: Links between persistent oil in mussel beds and predators
Name: Stephen C. Jewett

FORM 4B
Personnel
& Travel
DETAIL

2002 *EXXON VALDEZ* T TEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Contractual Costs:	Proposed FY 2002
Description	
Analysis (80 EROD samples @ $130/sample)	10.4
Freight	0.5
Contractual Total	$10.9

Commodities Costs:	Proposed FY 2002
Description	
Vials, labels, liquid nitrogen	0.4
Commodities Total	$0.4

FY02

Prepared:

Project Number: 02xxx
Project Title: Links between persistent oil in mussel beds and predators
Name: Stephen C. Jewett

FORM 4B
Contractual & Commodities
DETAIL

2002 *EXXON VALDEZ* TRU COUNCIL PROJECT BUDGET

October 1, 200. eptember 30, 2002

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2002
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number	
Description	of Units	

FY02

Prepared:

Project Number: 02xxx
Project Title: Links between persistent oil in mussel beds and predators
Name: Stephen C. Jewett

FORM 4B
Equipment
DETAIL

Transition Support for the GEM Data Manager

Submitted under the BAA

Project Number:	~~02455 BAA~~ 02655-BAA
Restoration Category:	Long-term monitoring and research
Proposer:	Charles Falkenberg
Lead Trustee Agency:	
Cooperating Agencies:	
Alaska SeaLife Center:	No
Duration:	1st year, 1-year project
Cost FY 00:	$112,400
Geographic Area:	No fieldwork
Injured Resource:	

ABSTRACT

The Gulf Ecosystem Monitoring (GEM) program will be hiring a data manager (DM) during this budget cycle and there will be a large number of tasks that the DM will need to address almost immediately. The design of the GEM data system will begin this year there are issues related to the data collected over the last decade by the projects funded by EVOS. In addition, the databases used to administer the EVOS projects may not meet the needs of the GEM program. The new DM will need to address all of these in one way or another. We are proposing several possible tasks to support the DM during this initial year in order to ease the transition to the GEM program. These tasks address the challenge of formulating a GEM data system, the rescue of legacy EVOS data, and the integration of the administrative databases. Although these are the priorities that have emerged from project 00455 we anticipate that the DM will set the final priorities and select one or more of the tasks proposed.

Introduction

By hiring a data manager, the GEM program will begin the process of establishing a long-term data archive that will become a significant part of the GEM legacy. The data manager will also begin the transition of the EVOS organization into a monitoring program that will collect and manage its own data. Indeed, one of biggest parts of this transition will be the requirements of managing data within GEM and providing the operational structure to accept, validate, store, and disseminate these data. The data manager will be the point person for a significant part of this transition.

EVOS project 00455 summarized the role of a data manager as follows:

- Articulating the vision of the data management system and data policies for GEM.
- Be the liaison between the GEM board and the data suppliers, the system users, and the developers of the system.
- Participate in the review of proposals for on-going monitoring projects as well as targeted research in order to evaluate the compliance with the GEM data policy. Approve the final delivery of the data from the project leaders.
- Oversee a staff that is responsible for maintaining the system, entering new projects, ingesting new data, and responding to needs of the user community

In this role the GEM data manager (DM) will face the initial challenge of establishing the framework for a GEM data system. This framework includes a comprehensive set of data policies, a data and information plan, an assessment of the user community and its needs, a data system architecture, and a management structure for the ongoing operation of the system.

The data manager will, at the same time, inherit the legacy of the projects that have been funded by EVOS for the last decade. This presents an opportunity as well as a challenge. GEM can begin populating a new system with data from the previous projects only if they can be gathered together with the necessary meta-data. Any data collection effort of this sort will have several obstacles to overcome.

We are proposing several tasks to support the data manger during the next year in order to provide the best opportunity for a successful transition. We have prioritized these in the context of our previous work on 00455 but we anticipate that the DM will bring their own set of priorities. Therefore we have structured this proposal to allow the DM to select one or more of these activities and refine and re-scope them as necessary.

Need for the Project

A. Statement of Problem

The challenges facing the data manager will be increased by the fact that there is no current staff to support many of the needed tasks. The data managers responsibilities will include the design and management of the new GEM data system, the legacy data from the current and past EVOS projects and the local administrative databases that are used to track these same EVOS projects. The demands of these three activities are quite different and managing them together will put considerable stress on the transition period.

GEM data system planning

This year will include the design phase for the GEM data system and a companion proposal could be part of that process. In addition to system design this initial phase will also see the establishment of the data standards, policies, and submission procedures. Much of this work will involve the stakeholder community in an iterative process similar to the development of the science plan. This process is time consuming and could easily occupy the majority of the manager's time.

EVOS legacy data

As the prior EVOS projects recede into the past and the data collected by them is no longer in current use, the understanding of the data and the meta-data that describe them fades. Although not all investigators are prepared to part with data yet, many are and others are retiring and may not be available when the GEM system is ready to accept these legacy data. GEM needs to provide a home for these data and short-term solution for safekeeping of the data and the meta-data that describe them. This too will demand the efforts of the new DM.

Project administration

Part of the meta-data describing the EVOS legacy is stored in the project databases that have been maintained over the years and used to administer these projects. Spatial coordinates, proposals, and final reports are part of the complete set of meta-data that describe the collection and intent of the datasets themselves. Although organizing the administrative systems is not of the highest priority, these system will play an important role in GEM data system and a critical role in decoding the details of the data already collected. The management of these databases is a third aspect of the new data manager's responsibilities.

B. Rationale

There are tasks within each of these three activities that can be encapsulated and delegated by the DM. A successful transition may well depend upon the DM delegating all of those tasks that can be done independently. We have identified several high priority tasks in each of these three areas as well as some additional support and prototyping tasks.

Although these represent our priorities it is important to allow the DM to make set the priorities for GEM and signoff on the deliverables for each task we propose. The DM

may want focus on the problem of historical data as a way of understanding the problems that must be addressed in the new GEM system. Alternatively, the DM may want to focus on the design of the GEM data system and postpone the difficulties of managing legacy data. For this reason we have left open the choice and final scope of the tasks to be done under this proposal.

We have, however, chosen tasks that we feel are of the highest priority. A data management plan will be the cornerstone of the system development, and EVOS data rescue activity needs to be addressed soon, and the integration of the administrative database with the science data system is a key recommendation of our prior work on 00455.

C. Location

Since this is a data system related project it is not tied to any particular region of the northern Gulf of Alaska. The work will be conducted at the Maryland offices of ECOlogic Corp. and at the EVOS meeting or ad hoc meetings in Anchorage.

Project Design

A. Objectives

The objective of this proposal is to support the activities of the GEM data manager and the tasks described below were selected because of the priorities set in 00455. However, before any of these is undertaken there will need to be a detailed statement of work that includes the specific deliverables along with a precise estimate of scope. If the DM identifies priorities that are not listed below, these too could be undertaken after a detailed statement of work was written and agreed too.

From the prior work in this area we have identified the following list of priorities and transition tasks for the initial phases of managing GEM data. These are listed in priority sequence and described more fully below.

- Develop a data management plan and the procedures needed for the plan to evolve. Establish an initial procedure for submission of data.
- Collect data from existing projects into a central location for safekeeping and create an inventory of these holdings
- Evaluate the administrative databases. Design an integration of the administrative databases and provide a scope of the effort needed to implement any needed changes.
- Undertake small prototyping tasks for targeted aspects of the new system. These might include integration with existing systems or targeted applications for specific user communities.

The GEM Data Management Plan

The GEM data management plan will describe the data to be collected, the standards that will be used, and the procedures for submitting data to the archive. In addition, the plan will summarize the philosophical approach to the data system but it will not include the design and architecture of that system. Like the science plan, the data plan will need to be reviewed by the GEM community and revised.

A key aspect of the plan will be the strategies that will be put into place to allow the plan to evolve. Over the lifetime of GEM, the technologies, data conventions and standards will all change dramatically. The GEM plan needs to include and ongoing review process that will allow new approaches to be integrated into a living document.

The plan will be developed under the direction of the data manager and it will require an experienced person to lead the effort. The scope will depend on the division of labor between these two individuals but a combined estimate would be several months and include review committee. Using the GLOBEC model this committee could be drawn from the research community as well as the data management community and take an active role in the definition of the final plan.

EVOS data rescue

There are many EVOS datasets that are currently at risk. These data are stored with the original investigators or their institutions. Although not all of the legacy data are at risk, in some cases the investigators are retiring or have completed their research with the data and are no longer interested in managing the data. It may be a few years before the GEM data system is prepared to accept new or legacy data and therefore temporary storage should be found for those datasets that are at risk of being lost. Providing an archiving option for legacy data is an urgent priority. If we postpone this until the system is in place for long-term archive and delivery valuable information could well be lost.

At a minimum this task would produce an inventory the data that currently exists, and is at risk, from key EVOS programs. The chief scientist and other investigators would identify these programs but they would necessarily include the three large ecosystem projects. The SEA data are no longer available through the SEA database, and the APEX and NVP projects do not have a central location for the storage of data.

A second goal would be to select an archive where the data could be stored for a few years and to collect and store these holdings for the future GEM data system. These data would be available to GEM but the goal is not to provide an online catalog and access.

ECOlogic currently has a wide array of computing resources and could host such a site. We have already looked into the possibility of moving the mirror site for SEA data to the machines at ECOlogic until the GEM system is ready and the SEA investigators release the data. However, there will be other possibilities for computer resources as well and these would be investigated as part of this task.

Not all legacy data are at risk. Some projects have done an excellent job of maintaining an ongoing database and some have made data available through a service such as CIIMMS. Indeed, some investigators are still working with data that they collected and would not be prepared to release it at this point. However, some investigators would be

anxious to see their data preserved and to fulfill the commitment to provide the data back to EVOS.

Administrative systems integration

The current administrative systems provide internal tracking for the projects funded by GEM and EVOS. A key recommendation of project 00455 is to link these administrative systems with the data system for GEM. This will allow the GEM staff to quickly evaluate data submission requirements and reporting requirements together. In addition, as this information becomes public, these reporting and data submission requirements could be available for review by the larger community.

The integration of the data and report submission systems and the project administration systems will not require a single, complicated, system. Using web technology these systems could be linked even if they were not designed and developed together. As an example, if the GEM project id was used in a web based data catalog, the administrative system could use a simple web address to display all of the dataset submitted by a single project. Likewise, an electronic library of reports could produce a list of the milestone reports by project id and this could also be easily displayed through the administration system.

However, to accomplish this link between administration and science data, a plan will need to be in place and some integration may need to be done. An additional benefit would be to get the information in the administration system displayed on the web without any additional work on the part of the GEM staff.

This activity will begin with an analysis of the current administrative systems along with the plans for archive the final reports. This, combined with the proposed data system architecture, will be used to design or recommend a system for maintaining project data and reviewing compliance with the proposal.

Prototyping

One of the key success factors for building a robust system is ongoing prototyping program. Risk is mitigated when ideas are tried out on a limited or simplified basis before significant funds are allocated. The GEM data manager will have several aspects of the new environment that need to be explored. Below is a list of some of the special projects that could benefit from a prototyping phase.

- **GIS integration and gap analysis** The GEM data system will need to provide an interface to an existing GIS in order to generate useful maps of the study and monitoring area and to provide input to the selection process for new projects. There are a number of possibilities in the GIS arena and a couple of prototypes would allow the DM to evaluate the results and make a more informed choice for a long term GIS solution.
- **Data submission and QA procedures** One of the most difficult problems for a GEM data system will be the evaluation and quality assurance of the data that will be submitted to it. Each dataset will have its own set of QA criteria and some will require the implementation and execution of QA routines. The process may result

in a resubmission of a new dataset by the data supplier that meets the QA requirements. A prototype could flush out the significant problems and keep this process from becoming too costly.

- **Integration with other data systems** Several EVOS researchers are already using a data system and making research data available to the public. The hydrocarbon database is a good example. However, the interface between these existing systems and the GEM data system is not as clear. A prototyping effort might expose the best way for these data systems to interact and result in a set of standards for GEM researchers that wanted to maintain a separate data system.
- **Integration with an external archive site** GEM may end up outsourcing the archiving task by using a computing facility at a third party. The will alleviate the problem of maintaining a data center but it will introduce several new problems. The data may need to be submitted to GEM directly in order to provide the proper QA before it is sent to the archive. Also a data system that is tailored to the needs of GEM but retrieves data from an external archive will have special requirements. A prototype may expose the problems and produce results that can be used in the decision making process.
- **User specific application development** One of the recommendations of 00455 is for GEM to provide a simple data access interface as well as targeted applications that are tailored to specific user communities. This will allow quick access to all of the GEM archive and useful applications for the management that is not prepared to perform a great deal of data analysis. A prototype of one of these applications would provide important feedback to the system architecture and design.

B. Methods

The methods described below for each of the proposed tasks are quite different and represent a general outline. Before any of the tasks are undertaken a detailed statement of work that describes the schedule and the deliverables will be written up and agreed to by GEM and ECOlogic. The budget described in this proposal will then be expended based on the completion of milestones described in the statement of work.

Data management plan

Project 00455 identified several good examples of data management plans that can be used as a starting point by GEM. These include the GLOBEC implementation plan, the plans used by APEX, and the data management plan from the EMAP project at the EPA. In addition, plans from NASA and other NOAA projects could be used to provide direction.

However the development of a data management plan will require the participation of the larger community and needs to be reviewed and directed by the DM and/or a small group of investigators. The GLOBEC plan, for example, required several meetings and was produced by team. However, there will need to be a coordination effort and the need to write up stawman proposals that can be debated and refined by the community. Building

on the GLOBEC plan and other like it, the GEM effort should be more straightforward and less effort overall. Our part could include the preparation of the reports and participation in the meetings.

EVOS data rescue

The data rescue task is more self-contained than the data management plan. The task includes collecting data and producing an inventory of data files and meta-data files. This task will require a high level contact to be made with the investigators by the data manager or senior person at EVOS but the collection of the data files and the creation of the inventory can be done by more junior staff. The results will be an electronic copy of the data submitted and a hard copy list of the files and description. In addition, the inventory can include the list of supporting documents that accompany the data such as final reports and proposals.

The steps include:

1. Identifying those datasets at risk
2. Contacting the investigators and arranging for the transfer of data
3. Gathering the data and the documentation into a single location
4. Producing and written inventory of the data
5. Producing a set of CDs or tapes that contain the data described in the inventory.

Step one will be based on the priorities that GEM has for the key data needed in the long-term archive. In addition, data that was collected by projects that are no longer funded or in which investigators are retiring would be prime candidates. Finally, the ecosystem projects should be included and any data not currently available should be rescued.

In some cases, step two will require the input from the senior GEM staff in to help initiate the data transfer and confirm that we are acting on behalf of GEM. The cooperation of the chief scientist for each ecosystem projects will also be an important factor.

The third and fourth steps will be administrative. The data will be collected and stored on a computing resource to be determined. Although ECOlogic has facilities to host these data there may be alternatives that are preferable to the data manager. The inventory document will catalog the data files and sources and make up the reporting mechanism back to GEM as to what has been submitted.

Although data backups will be done on a regular basis, periodically a CD or tape will be produced and sent along with the current inventory documents to the data manager to ensure that a recent copy of the data are available the GEM.

The computing facility must ensure a regular backup of the data files and access by the staff that is producing the inventory document. However, this is intended as safe storage for data at risk and not as a temporary data system with web-based access. In addition, our proposal does not include QA for the data. A final statement of work could modify

this assumption, but the process of data QA could easily double the scope of the effort. Finally, the goal is to provide a home for data that is at risk of being lost, not to pull data from sources that have adequate storage and access mechanisms in place.

Administrative database integration

The integration of the administrative databases will begin with an analysis of the current systems and an evaluation of a future need of GEM. The goal is to assess requirements and see how the current system meets these requirements. This might include the generation of the regular reports of the historical funding and draft work plans.

The second step will be to describe a way in which all of the data related to a single project could be viewed together. This includes the initial proposals, the final reports and interim status reports, and the science data that were collected. This capability could be quite valuable to the GEM staff in evaluating compliance and milestones for each project.

Much of the data stored in the administrative systems will be private to GEM but some of the data goes into the annual work plan and could be published on the web. The integration of web-based project data with the science data that were collected by project would provide public visibility into the status of a project and additional motivation to deliver the data that was promised in a proposal. In addition, a pointer to the publications that came from the project would be valuable for GEM and for any subsequent user of the data.

The next step will depend upon the results of the requirements analysis. The hope is to change a little as possible and still meet the requirements. However, new database technologies are more suitable for web deployment and these should be investigated as part of the requirements.

Budgeting

The budget for this proposal does not reflect any of the specific recommended tasks. It is designed to allocate funds that will be expended as the milestones in the statement of work have been reached. Overall the budget represents the value of about one half FTE split between senior staff and junior staff. The data management task will require a higher percentage of time at the senior level and the data rescue task will take a high percentage at the junior level. This reduction in cost will be offset by the allocation of funds to support the computing resources.

The actual allocation of the budget will be part of the detailed statement of work. It will not exceed the budget described below but it may not split in the same way.

C. Cooperating Agencies and Groups

The project will be led by Charles Falkenberg from ECOlogic Corp. and include additional staff from ECOlogic. Each of the projects will include a different set of

cooperating groups. The data management plan will require broad participation by the community along with detail evaluation by the GEM chief scientist and perhaps. The data rescue activity will require the cooperation of many of the prior and current investigators that have been funded by EVOS. The administrative database integration will include a working relationship with the EVOS staff that have maintained these databases for the last several years and with the Department of Natural Resources that developed the CD of EVOS projects.

Schedule

A. Measurable tasks for FY02 (September 2001 – August 2002)

September 2001:	Meet with the data manager and present prior work on 00455 and select task(s) to accomplish under this proposal. This could be done as early as July or August if possible.
January 14 or 21:	Attend EVOS annual meeting. Present the current status to the data manager or to the larger community.
April 15, 2002:	Report of the work done to date and plans for the remaining year.

B. Project milestones

The milestones include establishing the tasks to undertake and writing and agreeing to a complete statement of work and adhering to the milestones in the statement of work.

Reports

The April status reports will be produced irrespective of the tasks that are chosen. Other reports will be specified in the detailed statement of work and become part of the milestones for the project.

Principal Investigator

Charles Falkenberg
ECOlogic Corp.
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Phone: 202-218-4100
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Email: csfalk@ecologic.net

Charles Falkenberg has an MS in computer science and has been involved in building database systems since 1980. He was the principal developer of the archive and data system for the EVOS Sound Ecosystem Assessment (SEA) project. He has 20 years experience designing and building database systems and has worked for the last 6 years on several different scientific data systems. These included data management systems for hydrologic data, oceanographic data, NASA's Earth Observing System (EOS) data, and data environmental assessment at a local and national level. ECOlogic Corp. is a software development and consulting firm, specializing in spatial data management for science and industry. It is currently working on three NASA projects developing tools and applications for EOS data archiving and analysis.

Other Key Personnel

Steve Marley graduated from University of Leeds, United Kingdom in 1988 having completed his dissertation in Infrared Astrophysics. He has spent 13 years in the field of science data information systems. Initially at through developing Earth Observation data processing and ground segment management systems for both the British National Space Center (BNSC) where he developed the Synthetic Aperture Radar processing system for the UK data center for ERS-1, and later with the ESA team in Frascati, Italy where he supported ERS microwave instrument validation, and developed ground segment applications. Since late 1994 he has worked within the framework of NASA's Mission To Planet Earth program. For most of this time he was one of the senior systems architects of the EOSDIS Core System (ECS) ground segment developed to support NASA's flagship Earth observation platforms (Terra, Aqua, Landsat 7).

FY 02 *EXXON VALDEZ* TR E COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$106.4						
Travel		$6.0						
Contractual		$0.0						
Commodities		$0.0						
Equipment		$0.0	Estimated FY 2003					
Subtotal	$0.0	$112.4						
Indirect								
Project Total	$0.0	$112.4						
Full-time Equivalents (FTE)		0.5						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY02

Project Number: 02455
Project Title: Transition Support for the GEM Data Manager
Name: Charles Falkenberg

FORM 4A
Non-Trustee
SUMMARY

Prepared: Apr-01

FY 02 *EXXON VALDEZ* TRI E COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Personnel Costs:			Months Budgeted	Monthly Costs	Overtime	Proposed FY 2002
Name		Position Description				
Charles Falkenberg		Principle Investigator	2.0	19.0		38.0
Stephen Marley		Data Systems Consultant	1.0	22.8		22.8
TBD		Junior Engineer	3.0	15.2		45.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	6.0	57.0	0.0	
					Personnel Total	$106.4

Travel Costs:		Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 2002
Description						
EVOS Annual Meeting	Air fare & Hotel	1.0	2	10	0.2	4.0
Status Meeting	Air fare & Hotel	1.0	1	5	0.2	2.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$6.0

FY02

Project Number: 02455
Project Title: Transition Support for the GEM Data Manager
Name: Charles Falkenberg

FORM 4B
Personnel
& Travel
DETAIL

Prepared: Apr-01

FY 02 *EXXON VALDEZ* TRI E COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Contractual Costs:	Proposed FY 2002
Description	
Contractual Total	$0.0

Commodities Costs:	Proposed FY 2002
Description	
Commodities Total	$0.0

FY02

Prepared: Apr-01

Project Number:
Project Title:
Name:

FORM 4B
Contractual & Commodities DETAIL

FY 02 *EXXON VALDEZ* TR :E COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 2002
Description			
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number of Units	
Description		

FY02

Prepared: Apr-01

Project Number:
Project Title:
Name:

FORM 4B
Equipment
DETAIL

A 6,300-Year Old Window into the Past: Retrospective Analysis of Nearshore Marine Communities Based on Analysis of Archeological Material and Isotopic Analysis

Project Number: ~~02656~~ 02656
Restoration Category: Research

Proposers: Dr. Gail Irvine
USGS-BRD
Alaska Biological Science Center
1011 E. Tudor Rd.
Anchorage, AK 99503

Dr. Jeanne Schaaf
National Park Service
2525 Gambell St.
Anchorage, AK 99503

Lead Trustee Agency: DOI--USGS
Cooperating Agencies:
Alaska SeaLife Center: No
Duration: 2 years
Cost FY 02: $ 98.6
Cost FY 03: $ 18
Geographic Area: Gulf of Alaska
Injured Resource/Service: Intertidal communities, clams

ABSTRACT

The primary purpose of this proposal is to investigate long-term (6,300 year) patterns of productivity and relative species abundances in nearshore, intertidal communities via retrospective analyses. These analyses will focus on excavated midden remains of a very rich, well-dated archeological site along the Katmai National Park and Preserve coast. Changes in nearshore marine communities will be assessed through examination of relative species abundances, size-frequency analysis, and other indicators of habitat changes. Isotopic analysis of shells will provide an assessment of long-term productivity patterns in the nearshore marine environment as related to major periods of climate change.

INTRODUCTION

Changes in marine ecosystems occur on multiple scales of space and time. In the near-term, recent biological information suggests that patterns in the abundances of marine organisms and productivity of their associated systems may change in a low-frequency cyclical manner (e.g., regime shifts; Francis et al., 1998; Hare and Mantua, 2000), or may undergo longer-term directional change (e.g., Bering Sea; Schell, 1998, 2000). Long-term changes may reflect changes in climate that have spanned decades, centuries or millenia. Such changes are known for coastal regions from a variety of data. Within Alaska, the coastal paleoenvironments and climate of the late Pleistocene and Holocene have been reviewed by Mann and Hamilton (1995) and Mann et al. (1998).

Long-term changes in marine ecosystems are difficult to investigate, and the entrees into such data are limited. Cores, isotopic analyses, pollen-grain analyses, tree-ring data, and archeological investigations have been used to examine long-term biological data. A combination of data may provide a multi-faceted approach that allows integration and interpretation of changes and processes occurring in nearshore marine environments.

A tremendous opportunity to gain long-term perspective on biological change in nearshore marine communities bordering the Gulf of Alaska is afforded by recent excavations of a coastal archeological site along the Katmai National Park coast. This exceptionally rich site, being excavated by a team lead by Dr. Jeanne Schaaf, has midden material dated to at least 6,300 radiocarbon years before present (BP). This site is unusual in its long history, excellent organic preservation, and well-defined stratigraphy, which allows layers to be related to dated house floors. It is the oldest site identified along the northern Alaska peninsula, and the most extensively excavated site on the Alaska peninsula. Dating has indicated that the site was occupied from approximately 7,000 calendar years BP to approximately 500 years BP. Additionally, paleoclimate data have been collected in nearby areas, including analysis of a peat deposit that spans 10,000 years and that contains a tephra (volcanic ash) chronology and vegetational history of the entire Holocene (Hilton, 2000). The combination of radiocarbon dates and paleoclimate information provides a context within which a more detailed analysis of nearshore species found in midden remains can be made.

We propose a retrospective analysis of midden material to determine long-term patterns in nearshore productivity, their relation to climate changes, and ecological changes in composition of nearshore marine communities.

NEED FOR THE PROJECT

A. Statement of Problem

The GEM program is focused on monitoring species and processes in order to describe and understand changes in the oceanic and nearshore environments of the Gulf of Alaska.

As an early part of the program, it has espoused the need for retrospective analyses in order to enrich our understanding of long-term changes in this region. The shorter-term cyclical patterns in species abundances and climate that are a focus of much of GEM, must be understood against the broader spectrum of truly long-term (century to millenial) changes and more directional climate change (e.g., global warming). Retrospective analyses of archeological sites may allow development of such a perspective. The goals of the proposed project are to develop long-term patterns of productivity and relative species abundances in the nearshore and investigate their relationship to climate change.

B. Rationale/Link to Restoration

In order to understand the effects of the *Exxon Valdez* oil spill and other perturbations, we need to have an increased understanding of how species are changing through time. This project focuses on the nearshore environment, an area that was heavily injured by the *Exxon Valdez* oil spill. Developing an understanding of long-term change in nearshore marine communities and investigating the relationship between productivity and climate will aid in the development of the GEM monitoring plan.

C. Location

Study is focused on the Mink Island archeological site on the Katmai National Park and Preserve coast, bordering the Gulf of Alaska.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

Retrospective analysis of archeological specimens involves the revealing of human use patterns of resources. This could enrich the cultural history of local native groups. Additionally, querying local groups about findings may reveal whether similar use of nearshore species is made now or was in the recent past. We will be happy to discuss our findings with native groups.

PROJECT DESIGN

A. Objectives

1. Assess long-term patterns in nearshore productivity via isotopic analysis of shells of selected invertebrate taxa found in different, dated layers of middens.

2. Evaluate the paleoecology of the assemblages found in the middens via relative species composition, abundances, etc., and compare to patterns of productivity.

B. Methods

The hypotheses and methods used to address them are outlined below.

> H1: Changes in nearshore productivity, as evidenced by isotopic signatures of invertebrate shells, have changed in relation to major climate changes or trends in the Holocene.
>
> H2: Changes in species composition, sizes, etc., of midden species assemblages reflect changes in climate, habitat, or human use patterns.

The methods used to test each of these hypotheses are given below.

H1: Changes in nearshore productivity, as evidenced by isotopic signatures of invertebrate shells, have changed in relation to major climate changes or trends in the Holocene.

Recent analyses of stable isotope ratios of baleen of bowhead whales suggest declining productivity in the Bering Sea (Schell, 1998, 2000). In this case, analysis of carbon isotope ratios provided a means of indirectly assessing relative primary production. The bowhead whales feed on zooplankton that they filter with their baleen, and are thus one step removed from the phytoplankton primary producers. Bivalve molluscs, the dominant constituents of the middens at the Mink Island site, are also filter feeders, but feed more commonly on phytoplankton, thus responding more directly to patterns in primary productivity.

We propose a combination of carbon and nitrogen isotopic analyses ($\delta^{13}C$, $\delta^{15}N$, ^{14}C) of bivalve shells from the Mink Island midden to examine long-term changes in nearshore primary productivity. Carbon is transferred relatively conservatively in food webs and stable isotopic analysis of $\delta^{13}C$ gives excellent information on sources and magnitudes of productivity. Recent studies of the relationships between stable carbon isotope ratios in phytoplankton and the growth of diatoms (Laws et al., 1995) and for haptophytes inhabiting differing ocean productivity regimes (Bidigare el al., 1997) indicate a close relationship between $\delta^{13}C$ and algal growth rates (Schell, 1998, 2000). These findings provide a mechanism for linking $\delta^{13}C$ values and the magnitude of primary production, which can then be expressed in higher order consumers.

The addition of $\delta^{15}N$ analysis may allow finer discrimination of productivity differences, as changes in stable nitrogen isotope ratios also are related to productivity patterns, with higher $\delta^{15}N$ values related to higher productivity patterns (D. Schell, pers. comm.; Altabet and Francois, 1994).

Another measure of productivity (via upwelling), and one that has broader implications for the dynamics of deep ocean circulation is ^{14}C analysis. Comparison of the ^{14}C age differences revealed by analysis of paired wood (terrestrial) and marine shell samples reveal differences in ^{14}C age of atmospheric and surface marine carbon reservoirs. In

regions of upwelling, this is indicative of global thermohaline circulation. In subpolar regions, reservoir ages can provide information on the intensity of upwelling and mixing processes (Southon et al., 1990).

Our first hypothesis is that patterns of change in primary productivity, as evidenced by isotopic analyses, are correlated with changes in climate. Mann et al. (1998) have detailed the climatic history around the Gulf of Alaska (Fig. 1). We will select samples to analyze for natural stable isotopes ($\delta^{13}C$, $\delta^{15}N$) based on occurrence of radiocarbon dates (Fig. 2; Hilton, 2000) relative to the major climate periods. Bivalve shells tightly associated with the targeted radiocarbon dates will be analyzed. We estimate that 20 different time strata will be targeted, with an estimate of 20 bivalves analyzed for each radiocarbon date. Sample sizes will be based on the variability revealed by the isotopic analyses, coupled with availability of material. Preliminary testing of techniques will target recent material collected from the same area. Cross-sections of shells will be analyzed in order to integrate the temporal isotopic signal, since shells cannot be dated precisely (e.g., radiocarbon dating of house floors has some error associated with it [approx. ± 50-100 years], and variously shaped shell fragments may need to be analyzed). Additional preparation of shell material prior to isotopic analysis will be needed to remove inorganic carbonate.

^{14}C Analysis: Information obtained by Southon et al. (1990) from radiocarbon dating of shells and associated wood from coastal sediments in British Columbia suggest similar values to the present for reservoir age for most of the samples. However, data from a radiocarbon age of around 6,400 BP give a markedly different reservoir age than the older samples, suggesting that Holocene ocean circulation was much more variable than previously thought. Analysis of shell data from the exposed Mink Island site, when compared with associated charcoal dating of house floors (the latter ^{14}C data already obtained), would provide another time series of ocean mixing variability and the relationship of upwelling patterns across changing climate patterns of the Holocene. Additionally, such a time series, when compared with the British Columbia data would provide a broader view of long-term ocean circulation and its variability. This type of analysis cannot be done except at exposed sites, such as the Mink Island site bordering the Shelikof Strait, that are affected by coastal upwelling. A set of bivalve samples (estimated n=40) that are closely linked to radiocarbon-dated charcoal (from house floors) will be analyzed for ^{14}C via accelerator mass spectroscopy (AMS).

H2: Changes in species composition, sizes, etc., of midden species assemblages reflect changes in climate, habitat, or human use patterns.

An ecological analysis of the archeological midden material may reveal changes in the species composition and structuring of the populations through time. The temporal patterns in relative species composition of shell material at the site will be examined. Based on review of the relative abundance of the most common species (Foster, 1998, 2000) and the condition of the material, size-frequency data will be collected on one or a

few species. These patterns will then be compared to known climate trends and productivity information provided by the isotopic analyses. Since many of the species abundant at the site (e.g., *Mytilus trossulus*, *Saxidomus giganteus*) are common present-day organisms, an ecological analysis of species shifts may suggest either changes in climate or changes due to habitat shifts (perhaps due to sea level changes wrought by tectonic activity). Analysis of midden fauna in other locales (e.g., relative species abundance or size structure of abalones in the Channel Islands) has revealed changes thought to be caused by shifting ocean climate (Glassow, 1993) or alterations in predation intensity (Douros, 1993). Interpretation of the human use patterns of the site will also be incorporated into the analysis of climate, species abundances, and habitat changes in order to evaluate the observed biological changes as comprehensively as possible.

Cooperating Agencies, Contracts, and Other Agency Assistance

We will continue interaction and cooperation with researchers doing natural stable isotope analyses (Dr. Tom Kline, Prince William Sound Science Center; Dr. Don Schell, University of Alaska, Fairbanks). Contracts for natural stable isotope analysis are expected with the University of Alaska, Fairbanks. Another contract will be arranged for ^{14}C analysis via accelerator mass spectroscopy (AMS). A key cooperator will be Dr. Dan Mann of the University of Alaska, Fairbanks, who will be providing insight into Holocene climate change.

SCHEDULE

A. Measurable Project Tasks for FY02 (October 1, 2001- September 30, 2002)

Oct 1– July 31:	Set up contracts
Oct. 1- March 31:	Evaluation of climate record, midden materials for selection of target dates and shells for analysis
Oct 1 - July 31:	Evaluate isotopic techniques, preliminary assessments of recent material, test archeological material
Nov 30– Sept 30:	Isotopic analysis of shell material.
Jan 14-23 (2 days):	Participate in EVOS Annual Restoration Workshop
February 1- Sept 30:	Ecological analyses of midden materials
August, 2002	Present project results to Ecological Society of America
April 15, 2003	Draft final report

B. Project Milestones and Endpoints

FY02: Natural stable isotopic analyses of recent (test) bivalves and archeological midden shells
Radiocarbon (^{14}C) analysis of selected clam shells
Data analysis
Ecological analyses of composition/size structure of selected midden species

FY03: Data analysis and synthesis, draft final report (April 15, 2003), manuscript preparation

C. Completion Date

A draft final report will be produced April 15, 2003.

PUBLICATIONS AND REPORTS

A draft final report will be produced April 15, 2003. Manuscripts for publication will be produced in FY03.

PROFESSIONAL CONFERENCES

I plan to present the ecological analysis of midden materials to the Ecological Society of America (FY02); these meetings are held in August of each year. In FY03, I plan to present a paper on the isotopic analyses to the annual meeting of the American Society of Limnology and Oceanography in Albuquerque, NM.

NORMAL AGENCY MANAGEMENT

The work involved in this project is not part of normal agency management.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

As the research proposed is very multidisciplinary in nature, we will be coordinating and integrating information with other researchers using stable isotopic analyses, especially those involved in retrospective analyses. Additionally, we will integrate our paleoecological analyses with available information from other appropriate archeological sites bordering the Gulf of Alaska.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

N/A

PROPOSED PRINCIPAL INVESTIGATORS

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PRINCIPAL INVESTIGATORS

Dr. Irvine is a Marine Ecologist with the Alaska Biological Science Center. She has extensive experience in coastal ecosystems in Alaska, the Pacific Northwest and the tropics. Her primary research interests have focused on oil effects, the design of long-term monitoring programs and associated research, plant-herbivore interactions, succession, and life history dynamics. She is also interested in broad-scale and long-term research. Gail has been a Principal Investigator on several EVOS-funded studies involving oiled mussel beds and the residual oiling of coastlines and has been involved in publishing results from both projects. Recently she was invited to author a chapter on "Persistence of Spilled Oil on Shores and its Effects on Biota" for The Seas at the Millenium, a three-volume assessment of the state of the world's oceans published by Elsevier Scientific Press. Over the last 4 years, she has also been involved in designing protocols for broad-scale, inferential monitoring of intertidal assemblages in Glacier Bay National Park and Preserve, then adapting the design for the small coastline of Sitka National Historical Park.

Dr. Schaaf is Director of the Lake Clark-Katmai Studies Center of the National Park Service. She has organized and spearheaded the archeological excavations occurring over the last three years at Mink Island, Katmai National Park and Preserve. In her previous position as an archeologist in the Regional Office of the NPS, she was responsible for managing the Shared Beringian Heritage Program, the National Archeological Survey Initiative Gulf of Alaska Coastal Survey and the Alaska region Cultural Sites Inventory. Jeanne has been both editor and author of publications concerning cultural traditions and archeological studies in Alaska.

OTHER KEY PERSONNEL

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University of Alaska
Fairbanks, AK 99775

LITERATURE CITED

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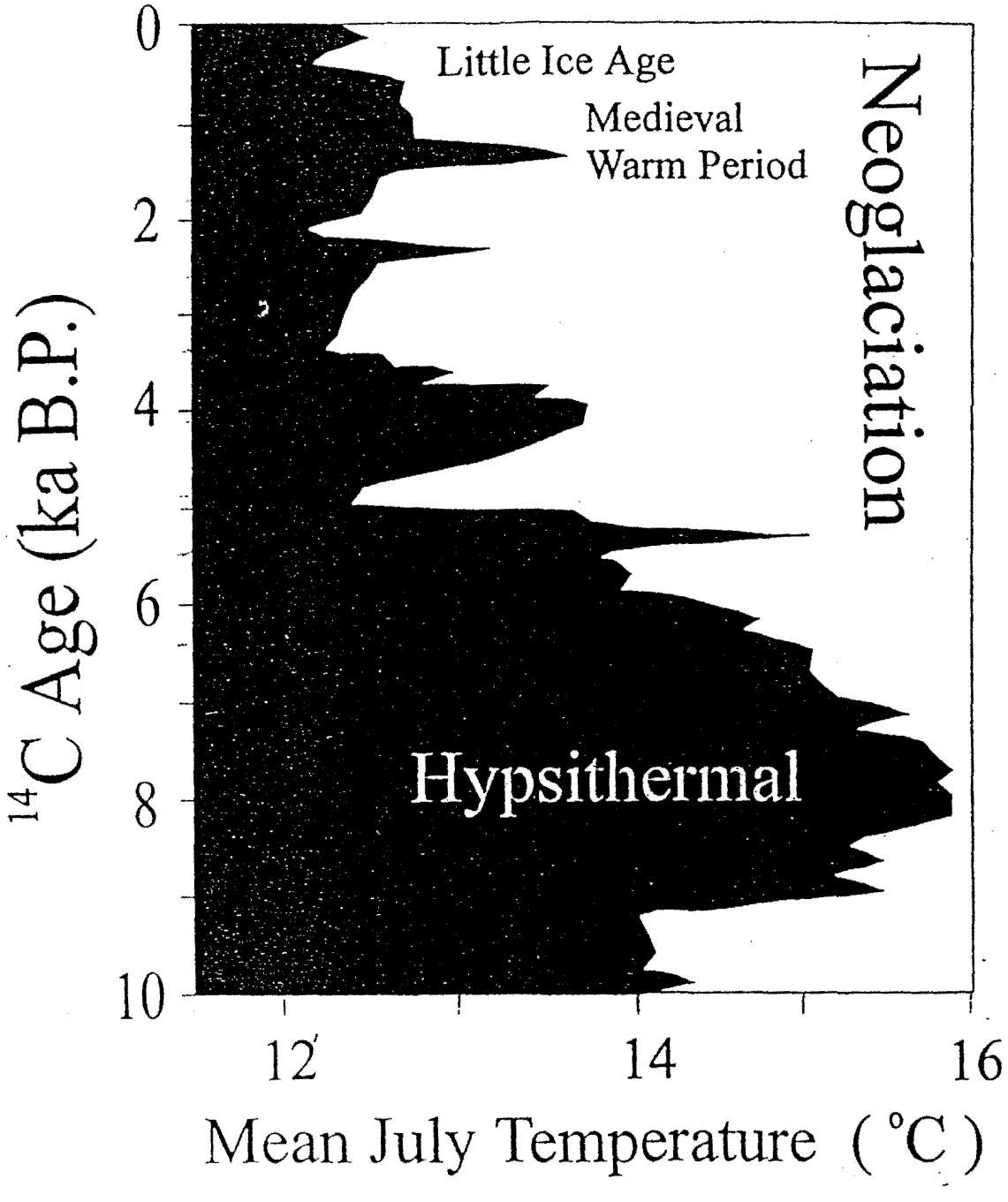

Figure 1. History of summer temperature in southern Alaska during the Holocene inferred from pollen transfer functions (redrawn from Heusser et al. 1985). The warmest period of the Holocene occurred between 9 and 6 ka, and was followed by Neoglaciation after 5-6 ka (from Mann et al. 1998).

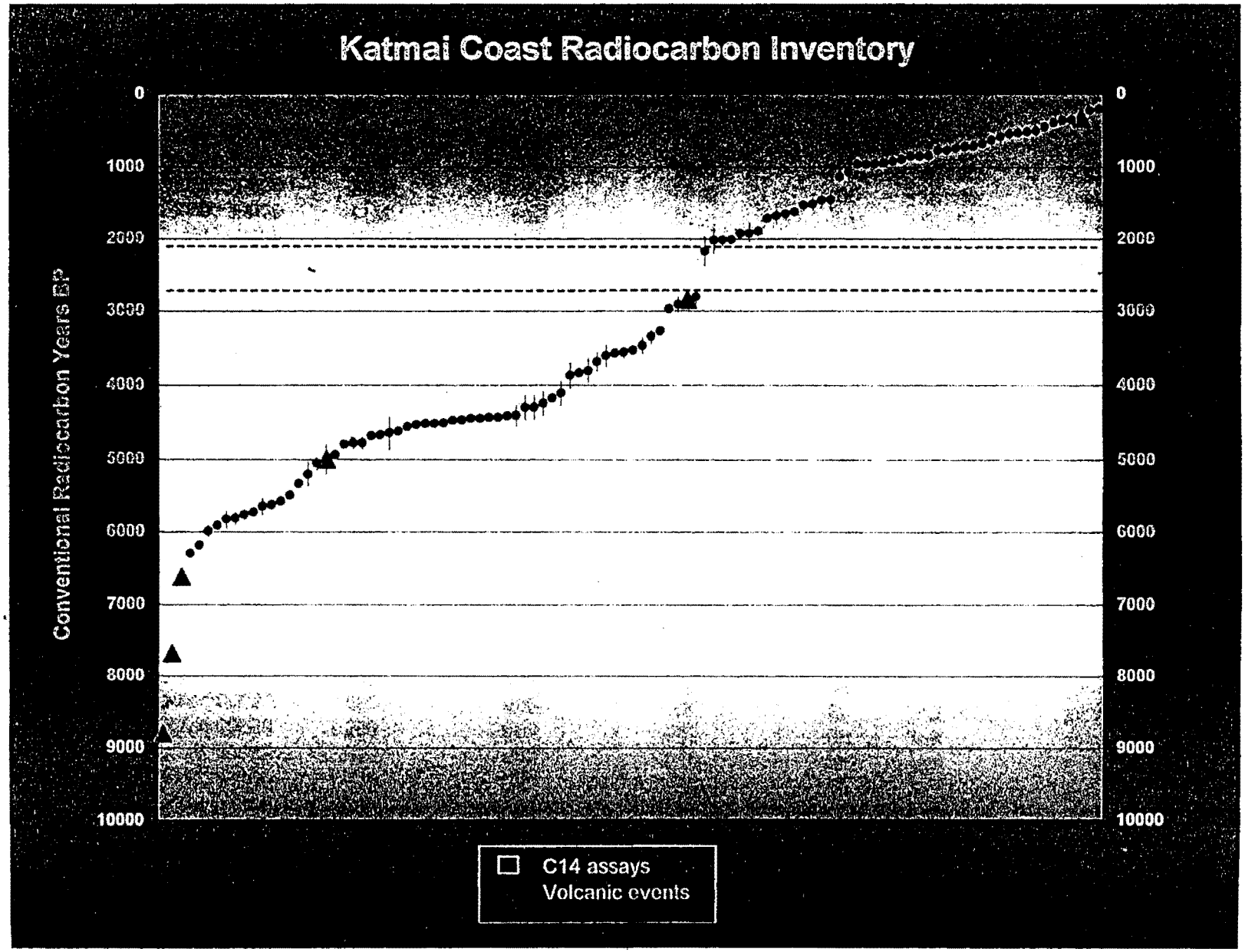
Katmai Coast Radiocarbon Inventory
Conventional Radiocarbon Years BP
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
C14 assays
Volcanic events

Figure 2.

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002	PROPOSED FY 2002 TRUSTEE AGENCIES TOTALS					
			ADEC	ADF&G	ADNR	USFS	DOI	
							$98.6	
Personnel	$0.0	$48.4						
Travel	$0.0	$3.4						
Contractual	$0.0	$37.0						
Commodities	$0.0	$0.0						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$88.8			Estimated FY 2003			
General Administration	$0.0	$9.8						
Project Total	$0.0	$98.6			$18.0			
Full-time Equivalents (FTE)	0.0	0.7						
	Dollar amounts are shown in thousands of dollars.							
Other Resources	$0.0	$0.0			$0.0	$0.0		

Comments:

FY02

Prepared: 4/13/01

Project Number: 06256
Project Title: A 6,300-Year Old Window into the Past...
Lead Agency: DOI--USGS

FORM 2A
MULTI-TRUSTEE
AGENCY SUMMARY

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002						
Personnel		$44.2						
Travel		$3.4						
Contractual		$37.0						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$84.6						
General Administration		$9.2						
Project Total	$0.0	$93.8						
Full-time Equivalents (FTE)		0.7						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

FY02

Prepared: 4/13/01

Project Number:
Project Title: A 6,300-Year Old Window into the Past...
Agency: DOI-USGS

FORM 3B
Personnel
& Travel
DETAIL

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2002
Gail Irvine	Marine Ecologist	GS 12/9	2.0	8.3		16.6
Vacant	Biologist	GS 9/1	6.0	4.6		27.6
	Subtotal		8.0	12.9	0.0	
					Personnel Total	$44.2

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2002
Consult with Dr. Don Schell, University of Alaska, Fairbanks; review lab and procedures	0.2	1	2	0.2	0.6
Present results to Ecological Society of America, Annual Meeting, August 4-8, 2002; Tuscon, AZ	1.3	1	6	0.2	2.5
Registration	0.3	1			0.3
				Travel Total	$3.4

FY02

Prepared: 4/13/01

Project Number:
Project Title: A 6,300-Year Old Window into the Past...
Agency: DOI-USGS

FORM 3B
Contractual & Commodities DETAIL

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Contractual Costs:	Proposed FY 2002
Description	
	0.0
	0.0
	0.0
Natural Stable Isotopic Analyses, 500 samples @ $26/sample	13.0
	0.0
AMS analysis of shell material, 40 samples @ $600/sample	24.0
	0.0
	0.0
	0.0
	0.0
	0.0
	0.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$37.0

Commodities Costs:	Inventory Agency
Description	
Commodities Total	

FY02

Prepared: 4/13/01

Project Number:
Project Title: A 6,300-Year Old Window into the Past...
Agency: DOI-USGS

FORM 3B
Equipment
DETAIL

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2002

Comments:

FY02

Prepared: 4/13/01

Project Number:
Project Title: A 6,300-Year Old Window into the Past...
Agency: DOI-USGS

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$4.2						
Travel		$0.0						
Contractual		$0.0						
Commodities		$0.0						
Equipment		$0.0						
Subtotal	$0.0	$4.2						
General Administration		$0.6						
Project Total	$0.0	$4.8						
Full-time Equivalents (FTE)		0.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

FY02

Prepared: 4/13/01

Project Number:
Project Title: A 6,300-Year Old Window into the Past...
Agency: DOI-NPS

FORM 3B
Personnel
& Travel
DETAIL

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Personnel Costs:		GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Proposed FY 2002
Name	Position Description					
Jeanne Schaaf	Archeologist	GS 12/9	0.5	8.3		4.2
						0.0
	Subtotal		0.5	8.3	0.0	
					Personnel Total	$4.2

Travel Costs:	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 2002
Description					
				Travel Total	$0.0

FY02

Prepared: 4/13/01

Project Number:
Project Title: A 6,300-Year Old Window into the Past...
Agency: DOI-NPS

FORM 3B
Contractual & Commodities DETAIL

2002 EXXON VALDEZ TR[illegible]EE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Contractual Costs:	Proposed FY 2002
Description	
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	

Commodities Costs:	FY 2002
Description	
Commodities Total	

FY02

Prepared: 4/13/01

Project Number:
Project Title: A 6,300-Year Old Window into the Past...
Agency: DOI-NPS

FORM 3B
Equipment
DETAIL